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Macroeconometric simulation of Irish dependence on the United Kingdom

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CHAPTER I. INTRODUCTION

The Republic of Ireland is a small open economy of 2.9 million people on 27 thousand square miles on an island off the west coast of Europe (Ireland. Central Statistics Office 1968, p. 4). Gross national product per capita is £500 or $1200. The country is not rich in natural resources and over 16000 people emigrate each year. The decade 1958-68 was characterized by economic growth with real GNP rising at an average of 4.1 percent per year. This compares with an average growth rate of 4.8 percent for the OECD countries as a whole (Organization for Economic Cooperation and Development 1969, p. 27). In the decade 1948-58 the Irish economy had an average annual growth rate of 0.7 percent. The raising of the Irish growth rate to OECD standards is regarded as a major achievement. The source of this growth was manufacturing industry which increased its share of national output over the period. From 1960 to 1964 its share was 29 percent, while from 1965 to 1969 its share was 33 percent. In contrast agriculture's share declined from 23 percent to 19 percent (Ireland. Department of Finance 1970, p. 120). The decline in the relative importance of agriculture accelerated the outflow of labor from the land. The difference between this outflow and the absorption by the rest of the economy accounts for most of Ireland's net emigration.

Ireland's Dependence on Trade

The dependence of Irish economic growth on the development of export markets is clearly recognized in the Government's Third Programme for Economic and Social Development:

> The decisive influence which external trading can exercise on the growth of the economy has been clearly shown in the course of the first and second programmes (1958-68). A rising trend in production and employment can only be sustained if the greater part of the end product can profitably be exported. Moreover, the growing imports of raw materials, semi-manufactures and capital goods, which are an inevitable concomitant of economic expansion can only be financed in the long run from export earnings (Ireland. Department of Finance 1969, p. 21).

From 1964 to 1969 exports averaged 33 percent of GNP and imports 39 percent. A 4 percent annual growth rate of GNP which is the official target of the Third Programme is estimated to require a 9 percent growth of exports and of imports. By 1972 this would increase exports to 43 percent of GNP and imports to 49 percent. This 4 percent annual growth rate of GNP falls short of the 5.5 percent which it is estimated is required to achieve full employment (5,000 net emigration) by 1981 (Ireland. National Industrial Economic Council 1967, p. 34).

Merchandise trade is the largest component of the Irish balance of payments. From 1964 to 1969 merchandise exports averaged 71 percent of total exports annually and merchandise imports averaged 92 percent of total imports. There was a substantial deficit on merchandise trade averaging £150 million a year, or 13 percent of GNP. Over 80 percent of this is financed by the other components of the current account which had an average annual surplus of £124 million. Of this, 32 percent is accounted for by tourism and travel, 16 percent by investment income and 13 percent by emigrants remittances. The remainder is financed by a net capital inflow which averaged £28 million from 1964 to 1969.

Demand Management in an Open Economy

Modern macroeconomic theory singles out aggregate demand as the key determinant of the level of economic activity in the short run. A high level of aggregate demand tends to push the economy to full capacity and to increase the rate of inflation; a low level tends to pull the economy below capacity and to decrease the rate of inflation. The implication for economic policy is clear: alter the level of demand to achieve the desired level of economic activity. Such a policy is known as demand management.

Aggregate demand can be affected directly by the government by altering the level of its own demand. Otherwise the government may use its taxing and spending powers or monetary policy to alter private demand. Thus, if the level of demand is deemed excessive, the government can either reduce its own demand or private demand or some combination of the two. If the level of demand is deemed deficient the government should increase its own demand or private demand or a combination of two. Such a demand management policy is said to be countercyclical. In Ireland, however, demand management policy has often failed to operate countercyclically.

The procyclical nature of Irish monetary and fiscal policy is a consequence of the openness of the Irish economy. The current balance of the balance of international payments is not only a component but a determinant of the level of aggregate demand. A worsening of the current balance reduces aggregate demand directly and is often followed by monetary and fiscal policies which further reduce aggregate demand.

Improvement in the current balance raises aggregate demand and is often accompanied by expansionary government policies:

> Low export demand has sometimes necessitated, as in 1965, deflationary public expenditure [policies] for balance of payments reasons at times when weakening of exports was itself exerting a restrictive influence. In 1966 exports were still not very buoyant in the first half of the year and the effects of this were reinforced by falls in nonexport demand following the further cutbacks in public expenditure programs announced in the budget. As ... the current external balance improved policies were relaxed. Public expenditure was greatly expanded in 1968 at a time when exports and private fixed investment were beginning to rise relatively fast... (Organization for Economic Cooperation and Development 1969, p. 26).

It is unlikely that Irish monetary and fiscal policies can be made to operate countercyclically. However, increased knowledge of the short-term impact of these policies can reduce their procyclical effect. Such knowledge can, in principle, be generated by estimating macroeconometric models.

Decision to Build a Quarterly Macroeconometric Model

While models based on an annual time period are undoubtedly useful, there is no substitute for quarterly models in the analysis of short term macroeconomic movements. These intra-year changes are of vital significance for demand management policy, and even for management of relatively large business corporations. No government waits for the annual figures before assessing the state of the economy or acting to alter undesirable trends. If such trends can be reversed then it is clearly desirable to do so as quickly as possible. This is especially true because of the time lags involved: the lag between data collection and data publication, the lag between data publication and the decision to change policy, the lag between the policy decision and its implementation, and the lag between the policy implementation and its effects on economic behavior. For these reasons most countries collect and publish short-term series which are used to assess economic conditions and to form a basis for economic policy changes. These series are also of considerable interest to the economic researcher interested in discovering the relationships among economic magnitudes. Such relationships tend to become obscured as the time period lengthens so that annual data may fail to reveal their existence. In a rapidly changing world, last year may be the same as pre-history to the economic agent. For these reasons quarterly macroeconometric models have been built at an increasing rate over the last twenty years.

A typical quarterly macroeconometric model has the form

$$AY_t + BY_{t-1} + CX_t = E_t$$

where Y_t, X_t, E_t are vectors of endogenous, exogenous, and residual variables respectively, and A, B, and C are coefficient matrices. Y_{t-1} is a vector of lagged endogenous variables. Such models are estimated by some form of regression analysis and it is assumed that A and B are constant throughout the sample period: they do not vary as t varies. (In practice, simple infrequent structural changes can be handled with dummy variables.) Clearly there is an upper limit to the length of the sample period for which constant structure may be assumed, and this limit is more restrictive for samples of annual as opposed to quarterly data. A sample size of twenty observations requires the sample period 1949-68 if the time period is a year and the sample period 1964-68 if the time period is a quarter. The assumption of constant structure is more easily maintained for 1964-68 than for 1949-68. This is the statistical advantage of a quarterly time period.

This advantage, however, must be weighed against the lower reliability of quarterly data (as will be discussed below). In addition, if seasonally adjusted data are used, the adjustment procedure may introduce errors of measurement. These problems notwithstanding it was decided that to build a quarterly macroeconometric model of the Irish economy for policy purposes would be a useful exercise.

Ireland's Dependence on the United Kigndom

Because of its dependence on trade, as noted above, a quarterly macroeconometric model of the Irish economy should contain a relatively disaggregated foreign sector. That is, several import and export functions should be included in the model. The export functions can most conveniently be related to United Kingdom (UK) variables because of that country's importance as a trading partner.

The U.K. accounted for 73 percent of annual merchandise exports and 55 percent of merchandise imports during 1964 to 1969. The bulk of Irish net earnings on tourism and travel (85%) are as a result of spending by residents of the United Kingdom. This close trading relationship is reflected by the Free Trade Agreement signed by the two countries in 1965. This provided for the gradual elimination of barriers to trade in industrial products and increased access to the UK for Irish agricultural exports. Certain agricultural exports would also be treated as UK domestic production for the purposes of subsidies and guaranteed prices. The Irish government has also applied for entry to the European Economic Community on each occasion that the UK has done so.

The close Anglo-Irish trading relationship is reinforced by relatively free movements of capital and labor between the two countries. The bulk of Irish emigrants go to the UK and there are close ties between corporations in the two countries. The Irish and British pounds have equal value and sterling circulates freely in Ireland. Irish financial intermediaries have access to the British financial markets and Irish interest rates are closely tied to their British counterparts.

Thus a quarterly macroeconometric model of the Irish economy, as envisaged by this researcher, would be built around several import and export functions. Although it would be possible to take the UK variables as exogenous, the availability of quarterly national accounts for the UK during the period makes it possible to estimate a model of the entire Anglo-Irish economy. This was the approach adopted by this researcher because it was felt that it would be useful to examine how changes in the UK affect the Irish economy.

The outline of the study is as follows. Chapter II derives quarterly estimates for Irish gross national expenditure and its components. This material is presented at this point because the limits prescribed by the data produced in this chapter determine the type of model that can be estimated. Chapter III is a review of relevant literature. Models designed to explain how fluctuations in economic activity are spread among countries are called transmission models of international trade. These models are reviewed in that chapter along with selected macroeconometric studies of the two economies. The model used in this study is derived and estimated in Chapter IV. Tests of its predictive ability are presented in Chapter V. Multipliers are presented in Chapter VI and a procedure for simulating the impact on Ireland of changes in the UK is illustrated. The study ends with a summary, conclusions and some suggestions for further research.

CHAPTER II. ESTIMATES OF IRISH QUARTERLY NATIONAL ACCOUNTS

Quarterly data are often less reliable than their annual counterparts. Because of limited resources complete censuses cannot be undertaken by national statistical offices very frequently. For this reason much data published by statistical offices reflects some degree of interpolation between census benchmarks, and the latest data reflect extrapolations from the most recent benchmarks. Because annual data reflect interpolations, the problem with quarterly data is not so much that they are interpolations, but that they usually reflect a greater degree of interpolation and that this interpolation is often performed using fewer or less reliable indicators than are available for the annual figures. For example, complete enumerations are often taken only once a year and the quarterly data are based on sample surveys. In addition, some data are only available once a year, such as certain tax returns and data in relation to unincorporated enterprises. Finally quarterly data may be less reliable than annual data because certain time errors become more acute as the accounting period shortens:

> This gives rise to two types of error. The first is usually called "float;" this stems from the fact that parties to the same transaction may nevertheless record it at different times, so creating a difference between the income and expenditures side of the accounts in any given period. Other timing errors occur simply because transactions are wrongly recorded. Both these types of error are relatively more serious for quarterly than for annual accounts (Organization for Economic Cooperation and Development 1968, p. 13).

The Irish Central Statistics Office does not publish estimates of Irish quarterly national accounts. What it does publish are short term economic indicators, such as a retail sales index and the number of new houses built. In principle, a macroeconometric model might be built using the short term indicators as was done for the United Kingdom (Klein, Ball, Hazelwood and Vandome 1961). A similar approach was adopted by Baker and Durkan in their analysis of Irish imports (1969a, 1969b, 1969c, 1970a). Such models however, are more useful for forecasting than for policy simulations, and an alternative procedure is to use the available indicators to make estimates of national accounts magnitudes on a quarterly basis.

The national accounts system has at least three advantages for the macroeconometric model builder: it reflects macroeconomic theory by classifying transactions into categories which have been found useful for economic analysis; it is a comprehensive and consistent accounting system which has been developed over many years to minimize errors of measurement and to provide as many alternative estimates of the same magnitude as possible, and it provides the model builder with identities - a most convenient device for handling macroeconomic variables.

Procedures for Interpolating Annual Data

Although quarterly estimates of national accounts magnitudes (except for trade figures) are not available for Ireland some unofficial estimates are available. R. C. Geary in an unpublished study estimated aggregates on the expenditure side of the accounts (Geary and O'Donoghue, 1968). Personal expenditure on consumers goods and services was estimated by regression against hotel receipts. Exports and imports of goods were obtained from the monthly trade statistics and all other magnitudes were estimated by regression against time. As will be seen below, a similar method was used in this study to estimate personal expenditure on consumers goods and services and exports and imports of goods but all other series were estimated differently. Dermot McAleese (1970) estimated Irish personal disposable income by interpolating the annual figures using the index of transportable goods output. That proceudre was not used in this study.

Quarterly estimates based on interpolation of annual figures can be derived in two ways: with or without using a related quarterly time series. It is preferable to use a related time series if one is available that is reasonably highly correlated with the series in question and if an appropriate interpolation procedure is applied. It was because most of the important series used in the macroeconometric model estimated in this study could be derived using related series that the researcher believed the project to be a worthwhile exercise.

Interpolation using a related series

Interpolation procedures using related series can be classified into those using correlation methods and those which do not. An example of a noncorrelation method is one where the trend of the two series is calculated using an average of the annual end points and some nonstochastic function of the deviation of the known quarterly value from its trend is imposed on the trend of the unknown series. In the simplest case let y_t be the unknown series and x_t be the known series (t =

-1, 0, 1, ...). Suppose y_{-1}, y_1, x_{-1}, x_o, x_1 are known and the problem is to estimate y_o. Let the deviation from trend be written

$$u = x_o - \tfrac{1}{2}(x_{-1} + x_1)$$

$$v = y_o - \tfrac{1}{2}(y_{-1} + y_1) \ .$$

The estimate of v, written $\dot{v}$, is some nonstochastic function (perhaps the identity function)of u so that the estimate of y_o, written $\hat{y}_o$, is

$$\hat{y}_o = f(u) + \tfrac{1}{2}(y_{-1} + y_1) \ .$$

Friedman (1962) suggests making f a stochastic function by regressing v against u, perhaps on an annual basis. This is an example of a correlation method.

In this study it was decided not to use deviations from trend as suggested by Friedman because estimation of the trend introduces an unnecessary source of error into the estimates. Rather it was decided to regress annual values of y on x directly and then estimate the quarterly values of y from the regression equation

$$y_t = a + bx_t \ .$$

The regression was estimated using annual values of x and y. Inserting quarterly values into this equation, however, would almost surely lead to extrapolation since some quarterly x_t would be outside the observed (annual) values. Thus it was decided to convert the x_t to annual rates by multiplying them by four before inserting them into the equation.

This would not eliminate extrapolation, however, because of the problem of seasonality. If a quarterly value is over 25 percent of the annual value because of seasonality, then at an annual rate it will be larger than the annual value. Thus, it was decided to correct the related series for seasonality before inserting them into the regression equation. This is also in line with the recommendation of Friedman (1962) who maintained that two series might be highly correlated but that the influence of different seasonal factors might reduce the correlation. As a result, the quarterly estimates are seasonally adjusted at annual rates. The seasonal adjustment procedure used will be discussed below.

Interpolation without a related series

It was not possible to estimate all the Irish national accounts aggregates used in this study using a related series. In those cases where no series was available quarterly estimates, seasonally adjusted at annual rates, were made using a technique developed by Sandee and Lisman (1962).

This technique fits a nonlinear trend to the annual data using a centered three year weighted moving average. Their analysis is in terms of x_t, one fourth of the observed annual total X_t. Their results are therefore quarterly values. But since their quarterly values are linear combinations of the x_t, the same linear combinations of the X_t will give quarterly values at annual rates. They begin from the model

$$\begin{bmatrix} Y_t^{I} \\ Y_t^{II} \\ Y_t^{III} \\ Y_t^{IV} \end{bmatrix} = \begin{bmatrix} a & e & d \\ c & f & c \\ b & f & b \\ d & e & a \end{bmatrix} \begin{bmatrix} X_{t-1} \\ X_t \\ X_{t+1} \end{bmatrix}$$

where Y_t^J is the quarterly value of the unknown series at an annual rate, J = I, II, III, IV. Notice that the coefficient matrix is symmetric. This assumption means that if $X_{t-1} = X_{t+1}$, then $Y_t^I = Y_t^{IV}$, $Y_t^{II} = Y_t^{III}$

Sandee and Lisman then derive six conditions on the coefficients a, b, c, d, e, f which enables them to solve the system. All these conditions except their sixth follow from their assumed model. The sixth assumes that the trend is a sinusoid which they regard as "a quite reasonable and natural condition for an alternating series in X_t." On inspection of the Irish data this assumption appears justified. (See Figure 2.1 for an example.) The solution to the system then becomes:

$$\begin{bmatrix} Y_t^{I} \\ Y_t^{II} \\ Y_t^{III} \\ Y_t^{IV} \end{bmatrix} = \begin{bmatrix} 0.291 & 0.793 & -0.084 \\ -0.041 & 1.207 & -0.166 \\ -0.166 & 1.207 & -0.041 \\ -0.084 & 0.793 & 0.291 \end{bmatrix} \begin{bmatrix} X_{t-1} \\ X_t \\ X_{t+1} \end{bmatrix}$$

This procedure yields seasonally adjusted estimates. All irregular movements are lost and the cyclical factor may be overemphasized. The reason for this is that a moving average of a random series will generate a cycle. This is known as the Slutsky-Yule effect (Yamane 1967, p. 870). However, this procedure was used only for very small parts of the national accounts and is the best that could be done in those cases.

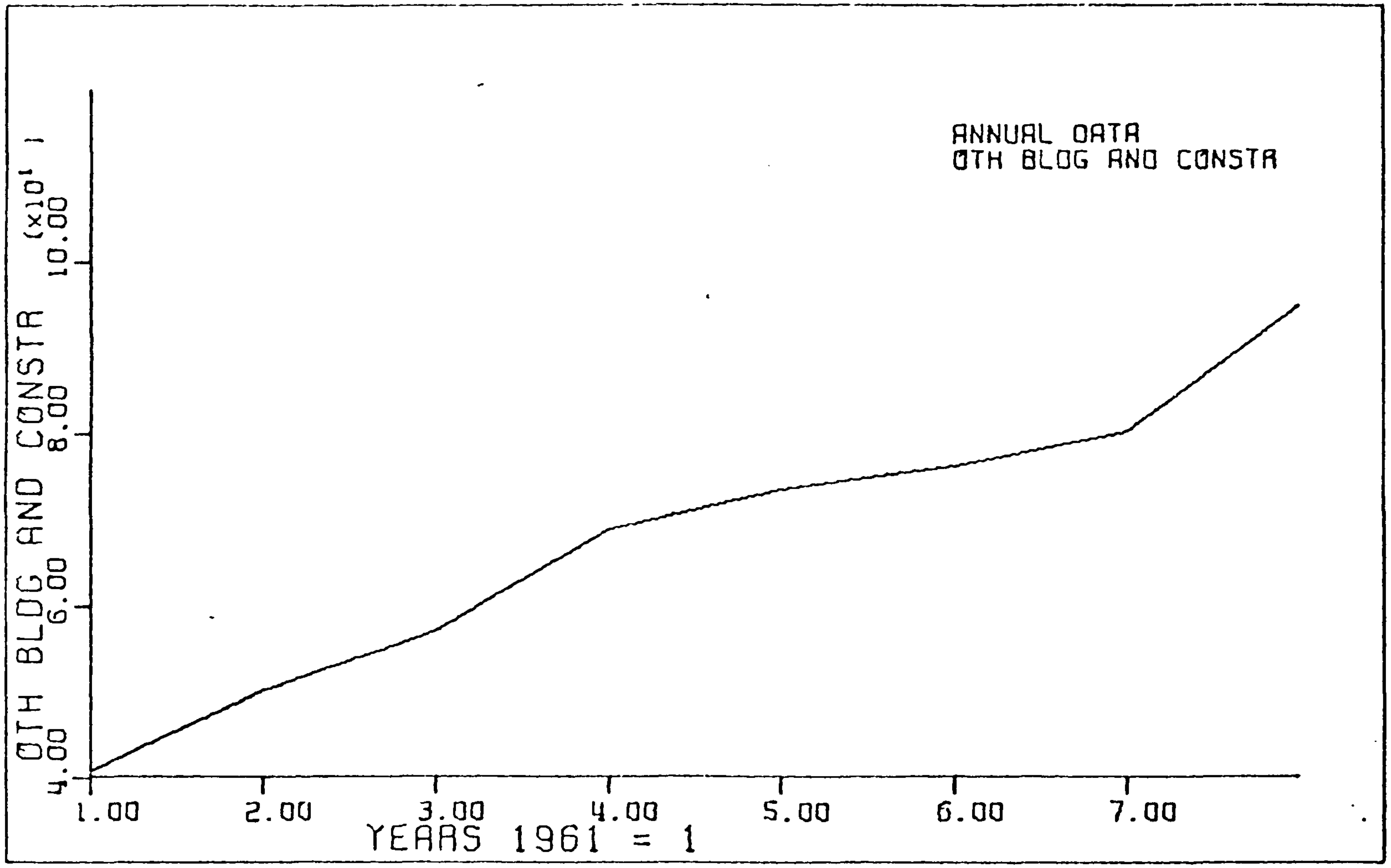

Figure 2.1. Annual data on other building and construction

Adjustment of the Quarterly Estimates to the Annual Totals

When the quarterly results were obtained it seemed natural to adjust them so that they summed to the observed annual total. This is usually done by national statistical offices. One way to do this would be to distribute the difference equally among the four quarters. This would not disturb the pattern of the last three quarters but would put all the adjustment between the fourth and first quarter. A second method would be to distribute the difference proportionately among the four quarters. This could still alter the pattern between the fourth and first quarters if the first year (fourth quarter) was adjusted in the opposite direction from the second year (first quarter).

The method of adjustment employed by the Office of Business Economics of the U.S. Department of Commerce to adjust the national accounts was developed by V. Lewis Bassie and later published in Bassie (1958, pp. 653-661). He fits a cubic polynomial to the required adjustments and finds each quarter's adjustment by taking the definite integral of the polynomial. To adapt his method for this study would be cumbersome so a nonlinear trend was fit using the Sandee-Lisman method (described above). The resulting adjusted series contained several different turning points than the unadjusted series. On the basis of these results it was decided that the Irish series contained too many fine movements to be amenable to such adjustment.

The Seasonal Adjustment Procedure

Quarterly estimates derived by smooth interpolation of the annual totals must be interpreted as seasonally adjusted. In addition, the interpolation procedure using related series discussed above provides seasonally adjusted estimates. Thus the question of which is better, seasonally adjusted or unadjusted data, for estimation of a macroeconometric model does not arise for this study. When seasonally adjusted series were already available they were adopted because this researcher believed that researchers in Dublin were better able to use personal judgment in estimating the seasonal variation. In other cases, the researcher used the ratio to moving average technique .

The ratio to moving average technique is used by the United Kingdom (Maurice 1968, p. 54), and has been put on a computer program by the United States Census Bureau. This program is employed extensively throughout the world (Shishkin, 1957).

The method of seasonal correction begins by adjusting the series for temporary special factors which might obscure the seasonality such as strikes. Then some model is hypothesized about the observations. Usually this model attributes the observed value (x) to the product (or sum) of cyclical (c) seasonal (s), trend (t) and irregular factors (e):

$$x = c \cdot s \cdot t \cdot e$$

First, an estimate of $c \cdot t$ is made. Leser uses his quasilinear trend method (Leser 1965a) but most statisticians use some form of moving average. Given the series of cycle by trend estimates $\widehat{ct}$, the observed series x is divided by it

$$\frac{x}{\hat{c}t} = \frac{cste}{\hat{c}t} = se \ .$$

Then some type of average of $\frac{x}{\hat{c}t}$ is computed to eliminate e (assuming T observations for each quarter)

$$\hat{s} = \frac{1}{T} \Sigma \ se \ .$$

Finally x is divided by s to yield the unadjusted series

$$\frac{x}{s} = \frac{cste}{\hat{s}} \cong cte \ .$$

The method can be applied with varying degrees of sophistication. Shifting seasonality over time can be allowed for by estimating $\hat{s}$ by a moving average. Some other measure of central tendency might also be used such as the mode or modified mean (average after the maximum and minimum values have been removed). It is this arbitrary or subjective nature of s that is the strength and weakness of the method. Allowance is made for personal judgment on the part of the statistician but no estimate of the accuracy of his judgment is provided.

Quarterly Estimates of Irish Gross National Expenditure and Its Components

The annual data on the Irish national accounts estimates gross national product in three ways: the income, output and expenditure methods. Only the expenditure side was estimated on a quarterly basis in this study because of the lack of information on quarterly agricultural income and output. Expenditure estimates are still useful, however, because they can be used to estimate aggregate demand and its component functions and these are of crucial importance for macroeconometric model building.

The expenditure estimates refer to the years 1961 through 1968. This period was chosen because 1961 was the first year of the retail sales index and 1968 was the latest year for which annual national accounts were available. The components of gross national expenditure were estimated in less detail on a quarterly basis than is provided annually. The breakdown adopted was dictated by the availability of suitable interpolation procedures.

Where interpolation was made using the Sandee-Lisman procedure more detailed estimates might have been presented. But the sum of the quarterly estimates of the detailed components would be equal to the estimates that would be obtained if the procedure was applied directly to the total. Since the resulting estimates must be viewed as unsatisfactory for estimating detailed functional relationships in a macroeconometric study, detailed quarterly estimates obtained by smooth interpolations are not presented.

The procedures by which quarterly estimates of gross national expenditure and its components were obtained are summarized in Tables 2.1 and 2.2. Smooth interpolations were made for investment in other building and construction, agricultural stocks, net factor income from abroad, and net exports of services other than factor income flows. Together these amounted to L145 million or 14.5 percent of gross national expenditure in 1968, as can be seen from Table 2.3.

Table 2.1. Summary of methods used to interpolate expenditure on gross national product in current prices

Component	Related series or smooth interpolation
Personal expenditure on consumer goods and services	retail sales index 1961-64 turnover tax receipts 1965-68
Gross domestic physical capital formation	
Building and construction	
Dwellings	new houses built under state-aided schemes
Other (including roads)	smooth interpolation
Machinery and equipment	
Imported	imports of producers goods ready for use
Home produced	volume of production by metals and engineering sector less exports of machinery and transport equipment
Value of physical changes in stocks and work in progress	
Nonagricultural	final expenditure
Livestock	smooth interpolation
Net expenditure by public authorities on current goods and services	supply services minus certain transfer payments
Net factor income from abroad	smooth interpolation
Exports of goods	merchandise exports
Imports of goods	merchandise imports
Net exports of services other than factor income flows	smooth interpolation

Table 2.2. Summary of methods used to interpolate expenditure on gross national product in constant (1958) prices

Component	Price deflator, related series or smooth interpolation
Personal expenditure on consumer goods and services	two quarter moving average of the consumer price index
Gross domestic physical capital formation	
Building and construction	
Dwellings	new houses built
Other (including roads)	smooth interpolation
Machinery and equipment	
Imported	wholesale price index for imported producer goods
Home produced	wholesale price index for capital goods
Value of physical changes in stocks and work in progress	
Nonagricultural	final expenditure in constant prices
Livestock	smooth interpolation
Net expenditure by public authorities on current goods and services	smooth interpolation of implicit price deflator
Net factor income from abroad	smooth interpolation
Exports of goods	export price index
Imports of goods	import price index
Net exports of services other than factor income flows	smooth interpolation

Table 2.3. Expenditure on gross national product in 1968 (Current prices in £ million and percent)

Component	Amount[a]	Percent
Personal expenditure on consumer goods and services	872	67.7
Gross domestic physical capital formation	269	20.9
Building and construction	145	11.3
Dwellings	50	3.9
Other (including roads)	95	7.4
Machinery and equipment	107	8.3
Imported	79	6.1
Home produced	28	2.2
Value of physical changes in stocks and work in progress	17	1.3
Nonagricultural	12	0.9
Livestock	5	0.4
Net expenditure by public authorities on current goods and services	169	13.1
Net factor income from abroad	58	4.5
Exports of goods	318	24.7
Less imports of goods	-485	-37.7
Net exports of services other than factor income flows	87	6.8
Total expenditure on gross national product	1288	100.0

[a]Source: Ireland. Central Statistics Office 1970a.

Other building and construction investment consists of roads and an "other" category in the annual tables. Expenditure on roads has shown little change during 1961-68 and such expenditure is planned in advance and in an annual program. Aside from seasonal factors which are assumed to have been eliminated here anyhow, it seems reasonable to assume that quarterly estimates of expenditure on roads followed a smooth trend. The remaining component of other building and construction investment followed a steady upward trend on an annual basis during 1961-68, rising in the recession year of 1966. The assumption of a smooth trend seemed reasonable for this item also.

Estimation of quarterly values for changes in the value of livestock numbers by a smooth trend is less satisfactory. This is the procedure followed by the U.S. Department of Commerce in making estimates for that country and their resources are much greater than those available to this researcher. However, this component of the national accounts has more significance in Ireland than the U.S. Data on livestock numbers is available for Ireland twice a year and in the future these figures may be the basis of more satisfactory estimates. Two problems will have to be solved: the June data will have to be corrected for seasonality and a seasonally corrected price index will have to be derived. It is likely that the resulting semi-annual estimates will be smoothly interpolated to provide the other two observations.

Smooth interpolation of net factor income from abroad was made after an unsuccessful search for related United Kingdom series. In particular quarterly data on investment income for the UK and its components, and on profits, were tried but the fit was always unsatisfactory on an annual basis. Future research on the capital account of the Irish balance of payments is likely to produce some usable related series.

Finally, net exports of services excluding factor income flows were estimated using a smooth interpolation. Tourist exports and imports were the largest components of this item. Considerable effort was put into finding related series for tourism. Hotel receipts from residents and non-residents were tried but with no success. These data were transformed and alternative functional forms were tried but again with no success. Data on passenger movements were also tried unsuccessfully. These results were disappointing to this researcher who was particularly interested in studying tourist exports.

The remainder of gross national expenditure and its components was estimated using related series. The results are presented in Tables 1-4 of Appendix A. The regression equations are presented in Table 2.4. The procedures followed are described in detail in the next section. The raw data for related series when not seasonally corrected was obtained from Ireland. Central Statistics Office (1961 through 1964) and Ireland. Central Statistics Office (1965 through 1970) unless otherwise specified.

Personal expenditure on consumers goods and services

Personal expenditure on consumers goods and services amounted to £872 million in 1968 or 67.7 percent of gross national product, and it is the availability of reliable estimates of this aggregate that makes

Table 2.4. Regression equations used in interpolating GNE

	R^2	F
$\log C = 1.0043 + \underset{(0.0084)}{1.1409} \log RS$	0.9998	18,417.0
$C = 42.977 + \underset{(1.5881)}{47.0732}\ TT$	0.9966	878.6
$\ln DC = -9.1867 + \underset{(0.0400)}{1.3928}\ H$	0.9943	1,212
$\ln DK = 2.0263 + \underset{(0.0045)}{0.1206}(H/1000)$	0.9902	708
$\log HP = 1.3597 + \underset{(0.0032)}{0.0098}\ MEV - \underset{(0.0271)}{0.0545}X7$	0.9227	428
$\log MPN = 2.7663 + \underset{(0.0010)}{0.0223}\ MP$	0.9858	485.7
$PS = 8.4024 + 10.1392\ PFE_{-1}$	0.9690	219.0
$S = 5.8094 + 7.5964\ FE_{-1}$	0.9520	132.9

Where C = personal expenditure on consumer goods and services
RS = retail sales index
TT = turnover tax receipts
DC = investment in dwellings in current prices
DK = investment in dwellings in constant prices
H = new houses built under state ordered schemes
MEV= volume of production of metal and engineering industrial group
X7 = exports of machinery and transport equipment
MPN= imports of producers goods ready for use adjusted for national accounts purposes
MP = imports of producers goods ready for use
HP = purchases of home produced machinery and equipment
PFE= final expenditure in current prices
FE = final expenditure in constant prices
PS = book value of nonagricultural stocks and work in progress
S = value of nonagricultural stocks and work in progress in constant prices

possible the estimation of the national accounts on a quarterly basis. Indeed the interpolation of the annual estimates to obtain the quarterly estimates is nothing more than an extension of the technique used to obtain the annual estimates themselves.

> In the main, the data underlying the quarterly estimates of consumer purchases...are essentially the same as those used to interpolate the annual estimates between the census based benchmarks....These data are based primarily on the relative movements of retail sales....(U.S. Department of Commerce 1958, pp. 96-97).

Ireland first published an index of average retail sales in 1961, and so quarterly estimates of personal expenditure on consumers goods and services can be made from that date.

National statistical offices do not rely solely on the retail sales index. In the United States "use is also made of unpublished compilations of sales tax data, sales data from trade associations and other private organizations, quantity and price information for individual groups of commodities and Federal retail excise tax collections" (ibid). This is because much personal expenditure does not take place in retail sales. For example, sales of services usually occur outside retail stores and these have been a growing part of the consumers budget. Thus, estimates of consumer services are usually made from information other than the retail sales index. Such detailed information on specific commodities was not available to this researcher, although some might be obtained. There is some information available on indirect taxes such as excise tax receipts on drink and tobacco and customs duties. Incorporation of this information into estimates on personal expenditure on consumer goods and services must await the future, however.

One indirect tax, the turnover tax was used here. This tax was introduced at the end of 1963. The tax rate (2½%) was left unchanged until 1970. The tax is collected with an average lag of one month and so a quarterly series lagged one month of turnover tax receipts provides a basis for interpolation of consumption.

From 1964 to 1968, therefore, there are two indicators of changes in personal consumption expenditure. If the two indicators have identical movements then it would not matter whether any one or both were used to perform the interpolation. Since regression was used, however, identical movements would probably cause problems of multicollinearity if both were used. On the other hand, if the movements in the two indicators diverged then either they reflected different parts of consumption or one was incorrect. To check out these possibilities the performance of the two series as indicators of the year-to-year changes in personal expenditure on consumers goods and services was examined. The turnover tax was converted to an index (1966 = 100) and two consumption indexes were computed (1961 = 100, 1966 = 100). The results are presented in Table 2.5.

Table 2.5. Performance of consumption indicators on an annual basis

	1961	1962	1963	1964	1965	1966	1967	1968
Retail sales index 1961=100	100	107	113	124	132	135	141	
Consumption index 1961=100	100	108	115	128	143	151	167	186
Turnover tax index 1966=100				88	95	100	107	118
Consumption index 1966=100				89	94	100	105	117

The choice of 1966 as the base year for the turnover tax index is not completely arbitrary. For reasons discussed below, in spite of the close fit for the turnover tax in 1964, the quarterly estimates are suspect in that year. Thus, 1965 was the earliest possible choice of base year. The 1968 estimates of the national accounts are still preliminary and so 1967 was the latest possible choice of base year. The year chosen was intermediate between the earliest and latest possible base years. Other possible base years were tried and the results did not differ significantly.

As can be seen from Table 2.5 the retail sales indicator tends to underestimate consumption and the turnover tax tends to overestimate it. Furthermore the turnover tax gives a much closer fit than the retail sales index in the period common to both indicators. The poorer performance of the retail sales index may have been due to the unrepresentative sample on which it was based. The sample was drawn on the basis of the 1956 Census of Distribution and the rapid structural changes in distribution after 1956 may have made the sample obsolete. Although a new Census was undertaken in 1966 a new index was not established until 1969.

Because of the poorer performance of the retail sales index it was not used as a related series for interpolation in the latter part of the period 1961-68. Surprising as it may seem in the light of the information contained in Table 2.5 the turnover tax was not used as a related series in 1964. This decision was based on the uncertainty surrounding the turnover tax figures in that year, the first year of its operation. This year was the only year in which the turnover tax index underestimated the consumption index. This underestimation may reflect the fall in seasonally adjusted turnover tax receipts in the third quarter--a fall which was not reflected by a corresponding fall in the retail sales index. In addition using the retail sales index as a related series for 1961-63 and turnover tax receipts for 1964-68 led to a fall in personal expenditure on consumer goods and services in the first quarter of 1964. This turning point was not reflected by the retail sales index either. For these reasons the retail sales index was used for 1961-64 and the turnover tax receipts for 1965-68.

Turnover tax receipts were seasonally adjusted by the indices calculated by Baker and Durkan (1970b). Seasonal indices for the retail sales index were obtained by the ratio to moving average technique. Quarterly estimates of personal expenditure on consumer goods and services in constant (1958) prices were obtained by dividing the current price estimates by the consumer price index. This index refers to the middle of the quarter and so a two quarter moving average was used. No seasonal adjustment was applied to the consumer price index, following Leser (1965a).

Gross domestic physical capital formation

Gross domestic physical capital formation amounted to £269 million in 1968 or 20.9 percent of expenditure on gross national product. This was subdivided into gross domestic fixed investment (£252 million) and the value of physical changes in stocks and work in progress (£17 million). Gross domestic fixed capital formation was composed of investment in building and construction and investment in machinery and equipment.

Investment in building and construction amounted to £145 million in 1968 or 11.2 percent of expenditure on gross national product. This was subdivided into investment in dwellings (£50 million) and all other investment in building and construction. The latter, as mentioned above was estimated by smooth interpolation.

Prior to 1955 the British Central Statistics Office estimated the quarterly figure for investment in dwellings by

> ...converting the number of starts, completions and dwellings under construction into an estimate of the numbers of equivalent completions in the period and multiplying by average prices per dwelling (Maurice 1968, pp. 377-78).

A crude form of this procedure was used in this study.

Officials of the Central Statistics Office told the researcher that the dwellings figure in the national accounts refers to houses completed and not work in progress. A related quarterly series was then found to be new houses built under state aided schemes. This series was amended in 1968 to include the (small) number of houses built without state aid. The revised series was used to provide estimates of the old series in 1968.

A series on the number of new houses built has the disadvantage that it does not adequately reflect changes in the value of these houses. The price of private houses has been rising spectacularly in Ireland over the last decade. On the other hand, the changing proportion of the total accounted for by government housing caused the implicit price deflator for dwellings to behave in a peculiar manner. It was concluded that changes in the value of housing cannot be incorporated into the estimates until the two components of dwellings are estimated separately. This must await the future. The houses built series was used to estimate both the current and constant price figures for dwellings. No seasonal adjustment was applied following Leser (1965a).

Because of the importance of the government in the Irish housing industry the annual figures for dwellings were taken to relate to the financial year. The quarterly estimates, however, refer to the calendar year.

Investment in machinery and equipment amounted to £107 million in 1968 or 8.3 percent of expenditure on gross national product. This was composed of investment of £79 million in imported machinery and equipment, the remaining £27 coming from domestic production. These figures reflect the fact that Ireland is a small country which is less industrialized than most Western economies and so most of its machinery and equipment is imported. The Central Statistics Office publishes a series of imports of producers goods ready for use which was used as a related series for imported machinery and equipment. The two series do not exactly coincide because certain adjustments are made to the trade figures for national accounts purposes (e.g., importers profit margins are added).

Seasonally adjusted import figures were obtained from Baker and Durkan (1969a) for 1961-63, Baker and Durkan (1970b) for 1967-68 and were calculated by this researcher for 1964-66. Baker and Durkan's 1964-66 figures were not used because they did not take account of the lumpiness of ship and aircraft imports on the seasonal indices. (It should be mentioned that it was their later work which pointed out the need to do this.) Estimates in constant prices were obtained by dividing the current imported capital estimates by the wholesale price index for imported capital goods.

Investment in home produced machinery and equipment was estimated using two related series: volume of production by the metals and engineering sector, and exports of machinery and transport equipment. Although this procedure gives good results on an annual basis, disaggregation would be likely to give greatly improved estimates. In particular, subdivision into electric machinery and nonelectric machinery should be possible. This development must also await the future. The constant price estimates were obtained by division of the current price estimates by the wholesale price index for capital goods. The volume of production index was seasonally adjusted using the ratio to moving average technique.

The value of physical changes in stocks and work in progress is composed of the value of physical changes in nonagricultural stocks (£12 million in 1968) and the value of changes in the number of livestock on farms (£15 million). The latter, as mentioned above, was estimated by smooth interpolation.

It is the opinion of this researcher that satisfactory estimates of changes in nonagricultural stocks cannot be obtained except by direct survey. In the absence of such surveys the choice is among unsatisfactory estimates and the figures presented in this study should not be used in a macroeconometric model except as part of a larger aggregate.

A possible indirect method of estimating stock changes would be to subtract estimates of final expenditure from gross national product estimates obtained by the output method and to interpolate the statistical discrepancy. No such output estimates are available for Ireland.

The alternative is to use a macroeconometric model which is normally used to explain stock changes as the basis for an interpolation. This approach is greatly hampered by the lack of data on total stocks. Although cumulation around an arbitrary origin can be, and in fact was, used the need for lagged total stocks on a quarterly basis for insertion into the regression equation precluded the use of any sophisticated model such as the "flexible accelerator." As a result, a very crude assumption was used: total stocks are a linear function of lagged final sales.

The researcher began with the identity

$$\Delta PS = P\Delta S + S\Delta P$$

which says that the change in the book value of (nonagricultural) stocks is the sum of the value of the physical change in stocks plus the adjustment for stock appreciation. The total book value of total stocks was obtained by cumulation around an arbitrary origin. This series was regressed against lagged final expenditure (the sum of consumption, fixed investment, government purchases, net factor income from abroad, and net exports of goods and services excluding factor income flows). Final expenditure estimates for the quarters of 1960 were obtained by regression of (quarterly) final expenditure during 1961-68 against the sum of merchandise imports and exports and forecasting the values corresponding to exports and imports during 1960.

Changes in the book value of stocks were obtained by first differencing the totals. The first differences taken were from corresponding quarters in adjacent years. Thus, the change in the book value of stocks for 196rI was the difference between the totals for 1964I and 1965I. This was done because stock changes are partly unintended and over a year some of the quarterly stock changes that are unintended will be eliminated. Quarterly stock changes cannot be multiplied by four to get the corresponding annual rates.

The second term in the identity above, the value of the physical change in (nonagricultural) stocks was estimated in a manner similar to that described above. The value in constant prices was regressed against final expenditure in constant prices (after cumulation around an arbitrary origin). The resulting estimates were first differenced and multiplied by the wholesale price index for the last month of the quarter. The third term in the identity was then obtained by subtraction. The average of the estimated quarterly values is compared with the actual annual values in Table 2.6.

Table 2.6. Comparison of actual and predicted stock changes (£ million)

Year	PS		PΔS		SΔP	
	Actual	Predicted	Actual	Predicted	Actual	Predicted
1961	16	21.6	13.1	13.1	2.9	8.4
1962	12.6	10.9	8.5	4.8	4.1	6.0
1963	12.9	13.2	9.0	7.7	3.9	5.4
1964	21.1	21.3	10.3	9.6	10.8	11.7
1965	12.5	13.7	7.2	4.9	5.3	12.2
1966	11.4	4.3	1.4	2.2	10.0	7.6
1967	9.3	12.1	0.5	8.6	8.8	3.4
1968	28.0	33.7	12	18.5	16	15.1

The results are surprisingly good considering the crudity of the procedure. The change in the book value of stocks and the value of physical changes in stocks showed the correct turning points except for 1967. If 1964 and 1965 were interchanged, the stock appreciation series would have the correct turning points.

Net expenditure by public authorities on current goods and services

Net expenditure by public authorities on current goods and services amounted to £169 million in 1968 or 13 percent of gross national expenditure. In the Irish national accounts this figure refers to the financial year (April 1 through March 31). Presumably this is regarded as the best available approximation to the calendar year, but quarterly estimates must be adjusted to refer to the calendar year.

The expenditure of public authorities is reported net of miscellaneous receipts and an allowance for depreciation of public buildings. In 1968 gross expenditure by public authorities on current goods and services amounted to £185.6 million. This was composed of spending by the central government, £100.0 million or 54 percent, and spending by local authorities, £85.6 million or 46 percent. Spending by the central government was further subdivided into wages and salaries (72 percent) and other (28 percent). The percentage of local government spending accounted for by wages and salaries was believed to be even higher than for the central government.

In the United Kingdom, where the organization of the government and its accounts is much the same as in Ireland, the main source of information on quarterly government expenditure is "a quarterly return by all Departments to the Treasury which provides an analysis of expenditure on supply services by economic categories" (Maurice, 1968, p. 295).

Similar data are available in Ireland but this researcher was unsuccessful in securing the cooperation necessary to obtain it. Thus there was no alternative but to use the Sandee-Lisman technique.

The errors introduced by fitting the trend are probably quite small based on the following argument. The high proportion of government spending that goes on wages and salaries together with the relatively fixed commitments by the government to its programs makes the current expenditure of public authorities a very stable component of gross national expenditure. This is borne out by the annual data; throughout the years 1961 through 1968 current expenditure by public authorities showed a steady upward trend. This feature is likely to hold also for seasonally adjusted quarterly estimates because government budgeting is on an annual basis.

No suitable price deflator appears to exist for government expenditure. On an annual basis, the government price deflator has increased rapidly. No other price deflator or index of wages shows the same growth. Thus the annual price deflator was interpolated using the Sandee-Lisman technique.

Net exports of goods and services excluding factor income flows

All items in the current account of the balance of international payments except factor income flows are included in gross national expenditure as exports and imports of goods and services. The balance of these items was a deficit of £80 million or 6 percent of gross national expenditure. This understated its significance for these reasons.

First, net exports of goods and services excluding factor income flows was computed as the difference of two very large items which together amounted to 74 percent of gross national expenditure. Second, net exports of goods is always a large deficit and net exports of services is always positive. In 1968 the deficit on goods or merchandise amounted to £167 million. This was of the same order of magnitude as net expenditure by public authorities on current goods and services (£169 million). Third, the deficit on goods and services is the most volatile component of gross national expenditure. In the period 1961 through 1968 this deficit varied from £87 million to L32 million. In comparison changes in the value of stocks varied from a decline of £6 million to a rise of £27 million in the same period.

Figures for merchandise trade are available in Ireland on a monthly basis but the annual totals of these figures are adjusted before being used in the balance of international payments. Three kinds of adjustments are customarily made: adjustments for timing, valuation and coverage (Maurice 1968, p. 458). Timing adjustments are made when the change of ownership occurred at a different time than the trade movement; valuation adjustments are made when the export or import price included some cost paid to a domestic agent; coverage adjustments are made when the trade figure included some item that properly belonged in a services category. The item "commission earnings of import agents" in the Irish balance of international payments is both a valuation and a coverage adjustment to the merchandise import figures.

The detailed information necessary to adjust the trade figures was not available to this researcher. The figures could have been adjusted by regressing the annual balance-of-payments merchandise figures against the sum of the monthly trade figures and then inserting seasonally adjusted quarterly sums of the monthly figures at annual rates into the equation. Since the adjustments made are not large or very volatile (see Table 2.7) the resulting estimates would have a high degree of accuracy. But then it would become necessary to disaggregate these figures by country and by functional or sectoral category for macro-econometric studies. Annual figures for these subaggregates adjusted for balance of payments purposes are not available and so the adjustments would have to be arbitrary.

On the other hand, a decision not to adjust the trade figures for balance of payments purposes can be justified. Inspection of Table 2.7 shows that the difference between net merchandise exports unadjusted and adjusted for balance of payments purposes was negligible in each of the years 1961 through 1968. In each year it was less than 1 million except 1968, but the figures for that year are still preliminary. It was therefore decided not to adjust the trade figures in this study. To ensure that the balance on current account remained unchanged, imports of "other known current items" were adjusted by the amount of the discrepancy between the adjusted and unadjusted figures.

Table 2.7. Comparison of merchandise trade figures, adjusted and unadjusted for balance of payments purposes (£ million)[a]

Unadjusted exports	180.5	174.4	196.5	222.0	220.8	244.3	285.1	332.5
Adjusted exports	169.8	164.6	186.4	212.3	211.4	234.9	274.1	318.4
Difference	10.7	9.8	10.1	9.7	9.4	9.4	11.0	14.1
Unadjusted imports	261.4	273.7	307.7	349.3	371.8	372.6	392.3	496.1
Adjusted imports	251.6	264.8	297.6	339.9	362.6	363.6	381.7	484.6
Difference	9.8	8.9	10.1	9.4	9.2	9.0	10.6	11.5
Unadjusted net imports	80.9	99.3	111.1	127.3	151.0	128.2	107.2	163.6
Adjusted net imports	81.8	100.2	111.2	127.6	151.2	128.7	107.6	166.2
Difference	0.9	0.9	0.1	0.3	0.2	0.5	0.4	2.6

[a]Source: Ireland. Central Statistics Office (1968) and Ireland. Department of Finance (1970).

Merchandise imports amounted to £318 million in 1968 or 90 percent of imports of goods and services. A functional disaggregation of merchandise imports is made by the Irish Central Statistics Office. Quarterly estimates of these subaggregates were seasonally adjusted and converted to annual rates. Most of the data were obtained from Baker and Durkan (1969a)and Baker and Durkan (1970b). The remainder were obtained by this researcher directly.

Merchandise exports amounted to £318 million in 1968 or 71 percent of GNP. Of this £9 million was accounted for by re-exports and £309 million was domestic exports. The Irish Central Statistics Office disaggregates domestic exports into agricultural, industrial and unclassified. Agricultural exports are further subdivided into cattle and other; industrial exports are subdivided into manufacturers and other by Baker and Durkan (1970b). Their data for the years 1963-68 were multiplied by four to convert them to annual rates. No comparable data were available prior to 1963 because Ireland adopted the revised SITC in that year. This did not pose a serious problem, however, because only the totals are needed for the national accounts. Quarterly estimates for total exports seasonally adjusted at annual rates were obtained for 1962 and 1963 by applying the seasonal indices estimated by Leser (1965a) to the observed quarterly totals. Constant price estimates were obtained by dividing the current estimates by the official export and import price indices.

Quarterly Estimates of Personal Disposable Income

The income variable used in estimating consumption and consumer import functions in macroeconometric models is not gross national product but personal disposable income. This is because personal expenditure depends not only on earned but also on transfer income net of taxes and retained earnings. The derivation of personal disposable income from gross national product in 1968 is presented in Table 2.8.

Taxes on expenditure include rates. Taxes on profits is the sum of taxes on undistributed profits and profits taxes paid by external concerns

Table 2.8. Derivation of personal disposable income from gross national product 1968 (£ million and percent)[a]

	Amount[a]	Percent
Gross national product	1288	100.0
less taxes on expenditure	237	18.4
less taxes on profits	55	4.3
less retained earnings	119	9.2
plus subsidies	60	4.7
plus transfers	144	11.2
equals personal income	1081	83.9
less personal income taxes	97	7.5
equals personal disposable income	984	76.4

[a]Source: Ireland. Central Statistics Office (1970a).

on the profits they earned within the state and government trading and investment income. Retained earnings is the sum of company saving and depreciation. Transfer payments include the national debt interest, and taxes on personal income include social insurance contributions. No adjustment was made for the financial year.

Some components of the series needed to derive personal disposable income from gross national product on a quarterly basis are available on a quarterly basis, especially tax data. It would be possible to estimate the remainder by interpolation although there are few related series. An alternative procedure can be justified, however. Table 2.9 indicates

Table 2.9. Comparison of expenditure on gross national product less taxes on expenditure and personal income, annual data in current prices 1961-68

	1961	1962	1963	1964	1965	1966	1967	1968
Expenditure on gross national product	726.2	782.6	838.2	949.8	1018.1	1070.6	1158.5	1288
less taxes on expenditure	114.8	118.1	130.4	154.2	168.5	190.5	209.6	237
equals	611.4	664.5	707.8	795.6	849.6	880.1	948.9	1051
less personal income	612.2	659.5	697.0	799.2	846.9	896.6	962.1	1081
equals	-0.8	5.0	10.8	-3.6	2.7	-16.5	-13.2	-30
difference as % of personal income	0.13	0.75	1.54	0.45	0.31	1.84	1.37	2.77

that gross national product less taxes on expenditure was approximately equal to personal income during each of the years 1961-68. The difference was less than one percent of personal income except in 1963 and 1966 when new taxes on expenditure were introduced, and 1967 and 1968, the figures for which are still provisional. This researcher decided, therefore, to use gross national product less taxes on expenditure and personal income tax as estimates of personal disposable income. Most of the figures for taxes were obtained from the office of the Revenue Commissioners. Smooth interpolation was applied to the annual figures for rates and some minor taxes on expenditure (such as harbor tolls). The "other" category includes all the estimates made by smooth interpolation. Seasonal adjustment was applied in a number of cases but great flexibility had to be allowed in the application of the ratio to moving average technique.

Data Constraints on a Quarterly Model of the Irish Economy

The econometric model builder is limited in the model he can estimate by the availability of data. In this case the availability of quarterly data on the Irish economy imposes five constraints on the model.

First, the sample period (1961-68) is dictated by the availability of quarterly national accounts. The lack of quarterly national accounts prior to 1961 was due to the lack of a satisfactory consumption indicator prior to that year; quarterly national accounts were unavailable since 1968 because that was the latest year for which annual data were available. Since the model was estimated in 1971, the 1968 constraint prevented the model from being used as an ex ante forecasting device.

The second constraint imposed by data availability is the lack of data on the income and output sides of the national accounts. As will be seen in the next chapter, the income variable in the consumption function is often disaggregated into agricultural, nonagriculture wages and nonagricultural nonwage income. In addition a profits variable is often included in an investment function. Such specifications were precluded in this model by the lack of available data.

On the expenditure side of the accounts the major gap in coverage is the lack of data on inventory changes. Klein et al. (1961) solved this problem by departing from the national accounts framework but this researcher rejected that approach although it does merit future consideration. What must be regarded as extremely low quality estimates of inventory changes were included with fixed investment to form the investment series used in the model. Thereafter inventory changes are ignored. This approach was adopted for convenience and can hardly be justified on theoretical grounds.

The lack of data on financial variables and the paucity of existing empirical research on the Irish financial sector, led to their exclusion from the model. Annual data on the capital account of the balance of payments is not very revealing. No quarterly data is available.

Housing investment was not singled out from fixed investment in the model, as is the common practice, because models of the housing sector utilize considerable numbers of financial variables (see Evans 1969, Chapter 7). Lack of financial variables was also among the reasons why cattle exports to the UK were not explained endogenously. UK farmers buy Irish store cattle on credit and their purchases are influenced by UK monetary policy. The failure to consider the output side of the accounts precluded disaggregation of Irish output and therefore was another reason why Irish cattle exports were not included among the endogenous variables.

Finally, certain limitations in data needed for the foreign sector limited the disaggregation made therein. Detailed monthly trade data is published by both countries but was not available to this researcher in the United States. Less detailed data is published by the U.N. and OECD but there were gaps in coverage in both sources (United Nations Statistical Office, 1961 through 1968, Organization for Economic Cooperation and Development 1961 through 1968). These were partly due to missing issues but also due to the revision of the SITC (Standard International Trade Classification) which was adopted by both countries in 1963. In addition, quarterly data for the first quarter in 1965 and 1966 were not published in the international sources.

Another problem with the trade data involved the need for appropriate price deflators and price indices. Consider an import function expressed in real terms and including a relative price variable among the explanatory variables. The price deflator should not include customs duties, as a wholesale price index does, but the relative price variable should. The solution, in principle, is to use unit value indices as deflators and wholesale price indices as relative price variables. In practice, the researcher must make ad hoc adjustments to whatever indices are available and hope for the best. Thus, unit value indices are extremely limited in coverage. The reasons for this is that the commodity composition of many important trade categories changes very rapidly and statistical offices usually attempt to maintain a constant commodity composition so that for such categories unit value indices are meaningless. Some suspicion also attaches to the wholesale indices which failed in both countries to indicate jumps when tariffs were imposed and at the time of devaluation. Indeed, in some cases, domestic prices rose considerably more rapidly than import prices after devaluation.

Since the primary objective of the model was the analysis of movements in Irish macrovariables, it was decided not to make the UK submodel any more complex than the submodel postulated for the Irish sector. This decision was made on intuitive grounds - the "balance" of a model designed to analyze the Irish economy should not be "tipped" in the direction of the UK economy. Because of the severe constraints which limited the complexity of the Irish model, the corresponding constraints imposed on the UK Model make it highly aggregative, compared to the available data. The data used was obtained from United Kingdom, Central Statistics Office (1961 through 1970 and 1970). The United Kingdom Department of Trade and Industry kindly made available some unpublished unit value indices subject to the proviso that they not be published or passed on. UK data on depreciation were obtained by smoothly interpolating the annual figures using the Sandee-Lisman technique. The annual figures were obtained from United Kingdom. Central Statistics Office (1970a).

CHAPTER III. REVIEW OF LITERATURE

The model envisaged by this researcher includes complete submodels of the United Kingdom and Ireland. As such it can be used to trace the impact of changes in the United Kingdom economic structure on the Irish economy. Models of international trade flows which seek to answer this type of question are called "transmission" models by Taplin (1967). This is to distinguish them from "structure of trade" models which are concerned with analyzing why particular trade flows occur among countries. Differences in the commodity composition of trade, or the share of one country in another country's imports are compared at different points in time. Then models are estimated to explain these differences.

Transmission Models of International Trade

The first systematic theoretical investigation of an n-country transmission model was undertaken by Lloyd A. Metzler (1950). He did not attempt to fit his model to data. He postulated a simple Keynesian model for each country based on the gross national expenditure accounting identity. Gross national expenditure (Y) was subdivided into consumption (C), investment (I), exports (X) and imports (M). Consumption and imports were linearly related to income. Investment was taken to be exogenous and exports, disaggregated by destination, were linearly related to the incomes of the recipient countries.

If X_{ij} is defined to be exports of country i to country j and M_{ij} is defined to be imports of country i from country j, then the simple

Keynesian model for country i is (with investment exogenous)

$$Y_i = C_i + I_i + X_i - M_i = C + I_i + \sum_j M_{ji} - \sum_j M_{ij}$$

$$C_i = \alpha_{oi} + \alpha_{1i} Y_i$$

$$M_{ji} = \beta_{oi} + \beta_{1i} Y_j$$

$$M_{ij} = \gamma_{oi} + \gamma_{1i} Y_i$$

It is noteworthy that the model assumes that the determinants of imports other than income, such as relative prices and exchange rates are constant. The transmission mechanism used by Metzler is conveniently summarized by Taplin (1967) as follows:

> An autonomous rise in investment in one of the countries increases output and income. The increased income leads, through the marginal propensity to spend, to larger expenditures on goods and services, both domestic and foreign. The expenditures stimulate exports from all the countries trading partners. The rise in exports increases the demand for domestic output and, therefore, income in those countries. Increased demand and income, of course, lead to larger imports. Metzler concludes that if the marginal propensities to spend are less than one the system is stable; that is, an autonomous shock will work its way through the system to a new equilibrium point (Taplin 1967, p. 444).

There were two attempts to estimate models similar to Metzler's which were published in the early 1950's (Neisser and Modigliani 1953, Polak 1954). These attempts were highly simplified because they dealt with large groups of countries for which little nontrade data was available. Neisser and Modigliani began with the hypothesis that

> short run fluctuations in the volume of imports and exports are chiefly attributable to fluctuations in the real income of the industrial countries. The mechanism of this relationship can be roughly described as follows: a rise in the industrial

> countries income increases their imports of raw materials and food, thereby increasing the exports of the non-industrial countries and enabling the latter, through their augmented purchasing power, to increase their imports of manufacturing goods, which come primarily from the industrial countries; a fall in the industrial countries income produces the opposite effects (Neisser and Modigliani 1953, p. 5).

The world is therefore divided into two regions, industrial and non-industrial and commodity trade is disaggregated into three categories: raw materials, food and manufactures. The industrial region was further disaggregated into the US, UK, Germany, France and Other. These five areas plus the nonindustrial region made a total of six.

Three import and three export functions were estimated (one for each of raw materials, food, manufactures). The import functions all contained a domestic income or output variable in some form. Some relative price variables were considered as were inventory changes and net capital flows. The export functions were based on the assumption of constant shares in partner countries' imports. Some modification of the constant shares hypothesis was allowed in certain cases by the inclusion of prices and time trends in the export functions.

The chief limitations of the model involve the assumed exogeneity of incomes and prices. The authors note that this exogeneity may be violated because income and prices depend on the endogenous variables (exports and imports) or because incomes and prices may themselves be interrelated (Neisser and Modigliani 1953, p. 18).

Exports and imports affect income through the national accounting income identity. The size of this effect depends on the size of the foreign trade multiplier. As stated, the model assumes that changes in income induced by foreign trade are offset by changes induced by other exogenous components of final demand (investment or government purchases). The authors recognized the limitations of this assumption, but inadequate data prevented them from responding beyond the point of making some ad hoc adjustments to the model.

The interdependence of prices and incomes could not be quantified but is explicitly discussed (Neisser and Modigliani 1953, pp. 116-119). A change in a country's income may affect its price level. In the absence of quantitative restrictions this price change will affect other countries import and domestic price levels via world prices. These price changes may affect incomes through investment changes (via expectations), through import changes (via price terms in the import functions), or through the balance of payments (by revaluing a country's net indebtedness or causing a change in balance of payments policies). This transmission mechanism via prices, although not empirically applied represented an advance of Metzler's model which ignored the role of prices.

Polak (1954) estimated a transmission model in which the income variables were endogenous. Although such a model might have been built by linking together models of national economies, Polak rejected this approach for three reasons:

> ...it would take years to construct even tolerably adequate models for, say, a dozen individual countries; and unless these models had been specifically constructed to reflect the countries' foreign relationships they might not be sufficiently reliable to be used for international linking, even though they gave a

> reasonably good description of the economy of the country concerned. For the great majority of countries, moreover, any attempt to construct a complete model would falter on the lack of statistics (Polak 1954, p. 14).

The Polak model centers on imports (M) which are determined by income (Y) The sum of every country's imports, world trade, determines each country's exports (X). Each country's exports in turn determines its income. Thus the model for country i has three equations: an import function, an export function and an income determination equation.

$$M_i = \alpha_i Y_i$$

$$X_i = \beta_i \sum_i M_i$$

$$Y_i = \gamma_i X_i$$

Exogenous variables such as investment and relative prices are added to identify the system. In addition, the income variable can be eliminated by combining the first and third equations.

The export function was criticized by Neisser and Modigliani (who saw the model prior to publication) on the grounds that it has no basis in economic theory (Neisser and Modigliani 1953, p. 57). The income determination equation, the most important innovation in the model, was also open to criticism:

> The assumption that income is a function of exports is quite reasonable for non-industrial countries whose exports are usually concentrated in a few products and which account for a large proportion of total output. It even may be reasonable for industrial countries like Luxembourg, the Netherlands, and Belgium, where the foreign sector is large. It is clearly less reasonable for industrial countries like the United States and Germany where the foreign sector is relatively smaller (Taplin 1967, p. 446).

Ten years after his book was published Polak returned to the analysis of the transmission mechanism in a joint paper published with Rhomberg who is still active in the field (Polak and Rhomberg 1962). Once again an international economic model was estimated directly:

> With respect to the construction of what is in effect a world economic model we are ... still in the impasse about which one of us complained ten years ago in connection with an earlier attempt to build a world model: we lack the national economic models that could be hooked together into a world model by linking their international trade connections. Since then even less progress has been made than might have been hoped in the construction of national models, and it is just as necessary now as it was then to proceed directly to the construction of a broad international model (Polak and Rhomberg 1962, p. 111).

Rhomberg continued working on the model after 1962 and published its most complete exposition in 1964 (Rhomberg and Boisseneault 1964).

The world was subdivided into three regions: the United States, Western Europe, and the Rest of the World. Import functions disaggregated by origin and destination are estimated for the United States and Western Europe. Explanatory variables include income, relative prices, inventory investment and capacity utilization. Imports of the rest of the world are determined by an identity since exports of the rest of the world are given by the industrial countries' import functions and the trade balance of the nonindustrial countries is equal to the sum (with sign reversed) of the net trade balances of the industrial countries corrected for additions to the monetary gold stock. The US and Western European shares in these imports depend on relative prices.

Taplin cites three advantages of the model:

> It does not make all income of industrial countries other than the United States dependent on exports, as the Polak model does, nor is income of the rest of the world predetermined as in the

> Neisser-Modigliani model. Rather income is predetermined for the industrial countries, but for the rest of the world income depends on exports. The fact that the model is closed is important. If errors are made in the assumptions underlying the projections and, e.g. imports of the United States from the rest of the world are estimated, exports to the rest of the world will also be underestimated. The resulting error in the trade balance, in all likelihood will be smaller than the original error.... The model also takes into account the role of demand pressure in imports.... The need for such a variable is due to the nature of unit value indices, the usual measure of import prices.... The index is not completely responsive to actual price movements, particularly when increased prices have caused particular commodities to be removed from the basket of goods traded. Furthermore, implicit price factors such as discounts or delays in filling orders are not accounted for at all (Taplin 1967, pp. 448-449).

On the other hand the model has several limitations. The income of industrial countries is clearly not exogenous although Polak-type export multipliers may not be sufficient substitutes for a complete model of national income determination. The model is highly aggregative and the capital account is largely ignored. The failure to incorporate lags may also weaken the results of the model.

Rather than attempting to explain the entire world trade matrix, a more fruitful approach might be to explain the trade among industrial countries. This accounts for the largest and most rapidly growing percentage of world trade and considerable basic data and econometric studies are now available. Work along these lines is preceding especially in relation to the OECD countries and the European Community (Adams et al. 1969, Resnick 1968).

The Adams study is a series of quarterly total import and export functions for the OECD countries. The explanatory variables in the import functions are industrial production, inventory changes, other cyclical variables, prices and dummies for trade liberalization, tariffs and strikes.

The export functions are linearized versions of

$$X_{ij} = \gamma_{ij} X_{\cdot j}$$

i's exports to j account for a certain share of j's total imports where the shares (γ_{ij}) depend on such variables relative export prices, relative pressure of demand and, where necessary, world business activity. No income determination equations are supplied. Perhaps the most significant finding of the study is the importance of cyclical variables.

The Resnick study of the European Community countries is the closest in conception to the model constructed by this researcher. The chief differences are Resnick's treatment of five countries with no commodity breakdown and this researcher's treatment of two countries with a commodity breakdown. In addition, Resnick's time period is a year while this study uses quarterly data. Resnick takes as his point of departure that

> the typical econometric application of fiscal policy to a model of one country will not be realistic if that country has close economic relations with one or more other countries. The multi-country case requires the development of a model that takes into account the various feedback relationships among them. The purpose of this study is to investigate empirically the effects of changes in economic policy within such a system, taking as the example the European Economic Community. The trade linkages among them are such that fiscal action by one or more will probably have measurable effects on all (Resnick 1968, p. 184).

The methodology employed is as follows:

> The model used in this paper represents the economy of each country (except Luxembourg) by a set of aggregate demand functions, consisting of consumption and investment equations and a domestic price equation. To study implications of the simultaneous feedbacks among the members, the model also includes a

separate equation for imports from and exports to every other member country. In total there are 50 structural equations to be estimated (Resnick 1968, p. 185).

The variables used were defined as follows for the i^{th} country:

Y_i = gross national product

C_i = personal consumption

I_i = gross domestic investment

G_i = government purchases

M_{ij} = i's imports from j

K_i = capital stock

SC_i = corporate savings gross of depreciation and dividends but net of corporate taxes

TD_i = personal and corporate direct taxes and social insurance contributions

TI_i = indirect taxes

TR_i = transfers

PC_i = consumer price level

PX_i = export price level

W_i = average hourly earnings

YD_i = personal disposable income

The foundation of the system was the income accounting identity with imports disaggregated by origin and exports disaggregated by destination:

$$Y_i = C_i + I_i + G_i + \sum_j M_{ji} - \sum_j M_{ij}$$

For convenience of exposition disposable income was introduced as

$$YD_i = Y_i - SC_i - (TD_i + TI_i) + TR_i$$

Ignoring disturbance terms and the logarithmic specification of the import functions, the structural equations estimated for country i were:

$$C_i = \alpha_{oi} + \alpha_{1i}\, Ci_{-1} + \alpha_{2i}\, YD_i$$

$$I_i = \beta_{oi} + \beta_{1i} Y_i - \beta_{2i} Ki_{-1}$$

$$PC_i = \gamma_{oi} + \gamma_{1i} Wi_{-1} + \gamma_{2i}\, TI_i$$

$$PX_i = \delta_{oi} + \delta_{1i}\, Wi_{-1} + \delta_{2i}\, TI_i$$

$$M_{ij} = \varepsilon_{oi} + \varepsilon_{1i} Y_i - \varepsilon_{2i}(PX_i/PC_i)$$

$$M_{j1} = \varepsilon_{oj} + \varepsilon_{ij}\, Y_j - \varepsilon_{2j}(PX_j/PC_j)$$

The system of consumption, investment and price equations were in recursive form and were estimated using ordinary least squares. The non-linear system of import equations were estimated using an instrumental variables technique. The estimated coefficients have the expected signs and most, except some price terms, are significant at the 5% level.

Viewed as a transmission model, Resnick's study contains two important innovations. First, a separate income determination model was estimated for each country. Thus, Resnick's study was the first empirical application of the Metzler model. Second, Resnick made his price variables endogenous, by means of mark-up equations.

Unfortunately, however, Resnick's specifications ignored some of the more important means by which transmission of economic fluctuations can occur via prices. In his model it is true that a change in hourly earnings in any one country will affect every other country's exports via the change in relative prices. On the other hand, Resnick's attempt does not go far enough because he does not consider the effect of changes in import or export prices on the domestic price level. In addition, the effect of income changes on the price level and therefore, the transmission of income changes via prices is ignored because of the exogeneity of hourly earnings and indirect taxes. A slowdown in economic activity in a country may lower hourly earnings and will certainly lower indirect taxes. In his model this should lead to a reduction in prices. On the other hand, if wage and tax rates are used in the price equation the outcome is less certain. Nevertheless, it seems likely that the level of economic activity will have some influence on prices and this effect should not be ignored.

Resnick uses his model to calculate government purchases and tax multipliers. His most important conclusion is that fiscal policy changes in any country will have an effect on the other countries which cannot be disregarded. One wonders, however, whether his model is an appropriate basis for such a conclusion. Because of frequent changes in tax rates, it is difficult to estimate tax functions and so many macroeconometric models have made taxes exogenous. Nevertheless taxes are surely related to income and spending and tax multipliers which ignore this relationship must be viewed with scepticism.

Similar caution must be exercised in interpreting the government purchases multipliers for a different reason: the model contains no financial variables. Although the omission of financial variables was probably unavoidable given the data limitations, the relevance of government expenditure multipliers which ignore the method by which the expenditure is financed, and its impact on financial flows, may not be considerable. This is aside from the problem of determining the significance of financial variables for the level of economic activity and prices.

Macroeconometric Studies of the Irish Economy

Prior to 1960 published macroeconometric studies of the Irish economy were a rarity. Since then, with the establishment and growth of the Economic and Social Research Institute, a number of such studies have become available. These studies have been concentrated in two areas: short term forecasting models and analysis of trade flows.

The second publication of the ESRI was entitled: "Short Term Economic Forecasting and its Application to Ireland" (Kuehn 1961). This was followed by the first forecasts made in 1962 (Kuehn 1962). C.E.V. Leser assumed the responsibility for the forecasts from 1963 through 1965 (Leser 1963b, 1964, 1965b). The forecasts for 1966 and 1967 were made by the Staff of the ESRI (Economic and Social Research Institute Staff 1966, 1967). Beginning with 1968, a Quarterly Economic Commentary was published whose senior Editor was T. J. Baker (Baker 1968). During this period (1960-68), the Institute began to publish seasonally corrected economic indicators and a Quarterly Industrial Survey of businessmen's expectations.

The forecasting models built by the staff at the ESRI are greatly influenced by data constraints. Although annual national accounts data are published by the Central Statistics Office, these cannot be used to estimate forecasting models. The reasons are summarized by Walsh:

> Irish data (like all others) are subject to serious revisions, so that it is always many years after the publication of preliminary estimates before the final figure becomes available: ...for example, the preliminary figure for national income in 1963 was 672 million while the (figure) published in 1970 (was) 677.2 million for 1963 national income, and further revisions will probably be made. In comparison with many countries that have developed working econometric macro-models based on national accounts data, the time lag in the publication of even preliminary estimates of the Irish national income data is so long as virtually to exclude the use of a macromodel for the preparation of helpful forecasts. If one uses an estimated model to 'predict' two years beyond the sample period for which it was estimated, in the Irish case the 'forecasts' thus prepared would be best applied to the national income magnitudes of the year in which the 'forecasts' were being prepared. Using the model to prepare genuine forecasts of future levels of GNP would involve using it for further beyond the sample period than can normally be expected not to result in serious inaccuracy (Walsh 1970, p. 19).

For these reasons, even the forecasting models based on annual data appear unfamiliar in the context of macroeconometric models.

Such models are usually estimated in terms of percentage changes using economic indicators (see Baker and Durkan 1970c). The equations also contain "adjustment terms". These are lagged differences between "variables which on a priori grounds might be expected to move roughly in line with each other. The expectation here is that any considerable divergence between two such variables in a year will lead to an adjustment in the opposite direction in the following year" (ibid., p. 20).

An example of a consumption function in such a forecasting model is

$$C = a_o + a_1 E + a_2 PA + a_3 (C - Y)_{-1}$$

where C is current consumption, Y is gross national product, E is an index of average weekly wage earnings in transportable goods industries and PA is an agricultural price index. All variables are expressed as percentage changes. Such a consumption function is of limited use for the type of model envisaged by this researcher as, indeed, is much of the research connected with short term forecasting in Ireland.

Two attempts, however, were made to estimate macroeconometric models of Ireland which were not dominated by forecasting requirements (Leser 1967b, Walsh 1970). Leser attempted to build a "basic" model, that is, a model which could be modified and extended to suit different purposes of analysis:

> The model introduced here is designed to explain short term movements, from one year to another, in some of the key national accounts variables. The relationships are such as to allow theoretical interpretation provided the specification is correct; failing the latter, they may still be used as prediction relationships. The model may be used in connection with short term forecasting though it is not specifically designed for that purpose, as it does not explicitly introduce short term indicators such as quarterly or monthly data which could be used for forecasting purposes. The model is fully recursive, specifying clearly the direction in which the relationships are supposed to work.... It could well be further extended to cover price indices and constant price terms, employment and other variables of this kind (Leser 1967b, p. 2).

The recursivity of the model is convenient for estimation purposes and permits easy modification of the model. Nevertheless, convenience is a dangerous criterion for choosing a specification and, perhaps, is best suited to models with an exploratory purpose.

All variables are in millions of pounds and current prices. Use of current prices is a specification error since economic theory deals with real variables and introduces spurious correlation among variables in a period of inflation. However, because Leser estimates the equations using first differences which tend to reduce R^2, it is not clear how much spurious correlation was introduced. The use of first differences which are frequently favored in some form by forecasters and which can sometimes eliminate serial correlation in the residuals of a regression equation has the severe disadvantage that it magnifies errors of measurement. This may partly explain why "most of the data, at the Δ level, fluctuates from year to year in quite fantastic degree" (Geary 1968, p. 2). The variables of the model are defined as

Y = gross national product

C = personal expenditure

I = gross domestic fixed capital formation

G = public authorities' net current expenditure

X = exports of goods and services

M = imports of goods and services

BA = value of physical changes in agricultural stocks

BN = value of physical changes in nonagricultural stocks

E = weekly earnings index in transportable goods industries

YD = personal disposable income

The model consists of the national accounts identity

$$Y = C + I + G + X - M + BA + BN$$

and four structural equations

$$C = \alpha_o + \alpha_1 YD + \alpha_2 (YD\text{-}C/YD)_{-};$$

$$M = \beta_o + \beta_1 I + \beta_2 (X = BA)$$

$$Y\text{-}G = \gamma_o + \gamma_1 I + \gamma_2 (X + BA) + \gamma_3 E$$

$$YD = \delta_o + \delta_1 (Y - G)$$

The first equation is a consumption function designed to represent the permanent income hypothesis. The second equation is an import function, but the theoretical basis is not provided. The third equation is a type of production function and the fourth equation replaces the national accounting identity for determining disposable income.

The model bears some resemblance to the Duesenberry, Eckstein, Fromm (1960) model of the U.S. economy in recession. The lack of an investment function therein might be justified for a recession period; the failure to include an investment function for Ireland might be justified on the grounds that the government is so large. Nevertheless, this researcher chose to make investment endogenous to the system, as will be seen below. Leser poses the question:

> To what extent to the equations formulated and estimated here have real structural context, and alternatively how useful are they for prediction; or else has the model fallen between two stools? (Leser 1967b, p. 8).

The forecasting ability of the model was tested by Geary for 1947-53 who found the results "generally disappointing" (Geary 1968). It also behaved rather poorly when tested as a predictor for 1967 and 1968 (Baker and Durkan 1970c, p. 31). In addition, re-estimation of the model using data up to 1968 showed considerable shifts in the estimated coefficients (ibid.). Baker and Durkan conclude that:

> In view of this apparent instability of the coefficients, the poor forecasting (and rearcasting) results of the original model, and the difficulty of using the model for current forecasting purposes (due to the fact that some of the necessary data are not available until the publication of the full national accounts for a year) it seems that this model is best regarded as an interesting experimental exercise.... (Baker and Durkan 1970c, p. 32).

The model does appear to fall between the two stools.

Walsh's model is an adaptation of the type of models constructed by Lawrence Klein prior to 1960 (Klein and Goldberger 1955, Klein et al. 1961). He published the model in 1970 because he believed it had "some merit as a starting point for discussion". He noted that it was originally estimated as part of a larger project and that he would change it if the opportunity arose.

The basic structure of the model consisted of the national accounting identity, a consumption function, investment function, two export functions and two import functions. Define the following variables:

GNP = gross national product

C = consumption

I = industrial fixed investment

XA = agricultural exports

XN = nonagricultural exports

MC = consumer imports

MN = other imported goods

O = other final demand = sum of government purchases, nonindustrial fixed investment, inventory changes, net exports of services, net factor income from abroad.

N = population

A = agricultural output

EA = agricultural employment

TI = profits

EI = industrial employment

W = wage income

SB = business saving

Q = industrial output

GNPUK = United Kingdom GNP

RPXN = relative price variable for nonagricultural exports

RPM = relative price variable for imports

The national accounting identity is

$$GNP = C + I + XA + XN - MC - MN + 0$$

and the six equations were specified as

$$C/N = \alpha_o + \alpha_1(A/EA) + \alpha_2(\ /EI) + \alpha_3 W$$

$$I = \beta_o + \beta_1 N + \beta_2 SB + \beta_3(\tfrac{1}{2} \sum_{i}^{2} Q_{t-i})$$

$$XA = \gamma_o + \gamma_1 XA_{-1} + \gamma_2 GNPUK$$

$$XN = \delta_o + \delta_1 GNPUK + \delta_2 RPXN$$

$$MC = \varepsilon_o + \varepsilon_1 C + \varepsilon_2 RPM$$

$$MN = S_o + S_1 Q + S_2 \ RPM$$

Fourteen other equations were estimated to close the model consisting largely of output and employment equations for agriculture and industry, interest and wage rate equations and price equations.

The consumption function distinguishes between three marginal propensities to consume (agricultural, wage and nonwage incomes). The investment function relates investment to lagged output, profits and a trend term which might represent the capital stock. The export and import functions contain some kind of income and price variables. As will be seen in the next chapter, the theoretical specification of the model is considerably outdated by recent research. No empirical results are presented in the paper cited.

With the establishment of the ESRI early attention was paid to the implication of international trade flows for the Irish economy, because of their obvious importance. Most work has been done in relation to imports, although one study has analyzed exports (Baker 1969).

Leser (1963a) published the first analysis of imports. He modified and extended the results in a later paper (Leser 1967a). The latter study used quarterly data. The quarterly volume of merchandise imports was regressed against the volume of industrial production (in transportable goods industries) as an indicator of income, and the difference between the quarterly price indices of imported and home produced goods. Seasonal dummies were also included.

The price and income coefficients were significant, implying a price elasticity of -1 and an output elasticity of somewhat less than one. Leser estimates that his results would imply a GNP elasticity of 1.6, given the relationship between industrial production and GNP.

Leser also estimated the same import function including a time trend. The result improved the fit, leaving the price coefficient largely unchanged, but considerably increasing the output coefficient. The coefficient of the time trend is negative and Leser interprets the results:

> as a short term effect which suggests that in the short run the volume of imports tends to rise or fall at least as fast as industrial production and perhaps a little faster. In the long run this short run effect appears to be partly offset by an autonomous reduction in imports .... This trend may represent the effects of gradual import substitution, adjustment to new production patterns and similar factors (Leser 1967a, p. 12).

Leser also estimated disaggregated import functions for food, drink and tobacco, crude materials, fuels and lubricants and miscellaneous goods:

> ...some general results were obtained. One finding was the absence of any lag in imports behind production but the presence of a 3-months to 6-months lead of crude materials imports over industrial production.... This lead of materials imports is of course plausible. Furthermore, prices seem to operate upon imports with a 3-month lag, except in the case of food, drink and tobacco imports for which no lag is discerned. There is a strong time trend for imports of miscellaneous goods but the trend, if any, is negligible for fuels and lubricants, and of doubtful significance for the other import categories (Leser 1967a, p. 12).

The results found by Leser accord with a priori expectations.

Nevertheless the economic specification of the functions is open to criticism. The peculiar specification of the price variable as a difference rather than a ratio has no basis in economic theory. As will be seen in the next chapter, import functions when derived from economic theory contain price ratios, so that some rationale should be provided for the use of price differences. The inclusion of a time trend in any economic model is undesirable, particularly when the equation already contains several other dummies. The major limitation of the study, however, from the point of view of this research project is the classification scheme employed for imports. The miscellaneous goods category cannot be incorporated very easily into a complete macroeconometric model.

An alternative classification of imports exists and formed the basis of later studies of Irish imports. In a series of articles published in the Quarterly Economic Commentary during 1969 and 1970, Baker and Durkan studied Irish imports, disaggregated by function into consumer, materials, and producer goods (Baker and Durkan 1969a, 1969b, 1969c, 1970a).

The focus of their study was short term forecasting so that most variables were expressed as percentage changes in current prices. Thus, their study is of limited value for this research except in one important respect; they isolated special events and components of Irish imports which would be exogenous to a macroeconometric model and which would prevent the accurate estimation of structural relationships. Strikes and government policy changes were tabulated; and the disruptive and exogenous nature of imports of unmilled cereals and ships and aircraft was pointed out. These results will be used in the next chapter. The forecasting emphasis of the exports study (Baker 1969) also limits its usefulness. The tabulation of special events is again useful but the classification of exports is of limited use to a (final demand) macro-econometric model.

One other study of Irish imports has been published (McAleese 1970) and his approach is similar to that of the present study. Quarterly merchandise imports c.i.f., less unclassified imports, deflated by an import unit value index is regressed against a relative price index, the wholesale import price (inclusive of customs duties) divided by the wholesale price of domestic production, and regressed against a synthetic disposable income series. Seasonal dummies are also included. A lagged value of the import term is also included. The inclusion of the lagged import term raises some estimation problems which were ignored.(Johnston 1963, pp. 211-221). Briefly, the Durbin-Watson loses meaning and if auto correlation exists the coefficients of the other variables are biased in an indeterminate direction. McAleese estimated an aggregate import function, and disaggregated import functions for consumer, materials and producer goods. None of the results of the Baker and Durkan analysis were incorporated.

Upper and lower bound price and income elasticities were calculated for each relation depending on variations of the specification. In addition, the inclusion of the lagged dependent variable permitted the estimation of short and long run elasticities.

The aggregate price elasticity was estimated as between -0.89 and -1.53. The aggregate income elasticity was estimated in the range 1.87 and 2.15. Three possible reasons for this high income elasticity are suggested:

> First, the income content of domestically produced goods is high. Raw and semiprocessed materials must be imported in the absence of domestic substitutes. Secondly, as GNP grows, the demand for the capital goods necessary to produce the additional output also increases, and few of these capital goods are manufactured domestically. Thirdly, as standards of living rise, demand for luxury consumer goods increases, many of which are supplied from abroad. Higher incomes also stimulate the demand for a greater variety in consumer goods, a demand which cannot be satisfied by domestic producers (McAleese 1970, p. 2).

The results of the disaggregated equations will be discussed in the next chapter.

Macroeconometric Studies of the United Kingdom Economy

The first macroeconometric models were estimated by Tinbergen for the American and Dutch economies (Tinbergen 1937, 1939). At about that time he also estimated a model of the United Kingdom for the period 1870-1914 which was published later (Tinbergen 1951). A crude small model was estimated by Radice before World War II (Radice 1939) and that comprised the entire literature on macroeconometric models of the United Kingdom prior to Klein et al.(1961). This reflected a lack of research interest on the part of British economists who may have tended to have a theoretical rather than empirical orientation.

For the Klein et al. model

> three basic decisions were made at an early stage of the work, and these have greatly influenced the final outcome. It was decided (1) to build a quarterly model, (2) to include only post war time periods, (3) not to adhere rigidly to a design built around the national accounting framework (Klein et al. 1961, pp. 2-3).

The decision to build a quarterly model implied the decision not to adhere rigidly to the national accounts framework because of the unavailability of quarterly national accounts data at that time.

Understanding of the model is greatly enhanced if the route out of the national accounts framework chosen by Klein et al. is reconstructed. To do this define the following variables:

GNP = gross national product

C = consumption

I = fixed investment

G = government purchases

X = exports

M = imports

ΔS = inventory changes

Q = some measure of national output other than GNP

The national accounting identity is

$$GNP = C + I + G + X - M + \quad S$$

In a traditional (Keynesian) macroeconometric model, aggregate demand determines aggregate supply (GNP) so that once aggregate demand is determined by structural equations for C, I, G, X, M, ΔS, then GNP is determined by the identity.

Klein had no observations on ΔS, so that he could not use the identity to determine GNP. Instead he formulated a production decision equation to fulfil that role:

$$GNP = f(C + I + G + X - M)$$

Then, in principle, the identity could be used to determine ΔS as a residual. No observations on quarterly GNP were available, however, so that the production decision was specified in terms of the best variable available, the volume of industrial production Q:

$$Q = g(C + I + G + X - M)$$

Thus the GNP identity was discarded and ΔS was ignored.

The prototype model, then, contained the following equations:

$$Q = \alpha_o + \alpha_1(C + I + G) + \alpha_2 X$$

$$C = \beta_o + \beta_1 W + \beta_2 \Pi + \beta_3 C_{-1}$$

$$I = \gamma_o + \gamma_1 \Pi - \gamma_2 r$$

$$M = \delta_o + \delta_1 Q - \delta_2 RPM + \delta_3 R$$

where the new variables were defined as follows:

W = wage income

= nonwage income

r = interest rate

RPM = relative price variable for imports

R = reserves

Seven other equations were specified to close the system, determining the price level, wage and interest rates, employment and unemployment, and nonwage income. In the quarterly model many of these functions were disaggregated and more complicated lag structures were introduced. The most remarkable feature of the model, its departure from the national accounts, now ensures its obsolescence because of the availability of detailed quarterly national accounts for the last ten years.

Most macroeconometric research that has been done on the UK in recent years consists of detailed studies of individual sectors of the economy. This very detail, however, makes them of limited use for this researcher. For example, there is a considerable literature on the demand for consumer durables, especially cars (Stone and Rowe 1957, Dicks-Mireaux et al. 1961, Galambos 1962, Ball and Drake 1963a, O'Herlihy 1965, O'Herlihy et al. 1967). Much of this literature is concerned with the impact of monetary policy on durables purchases. Since this researcher did not disaggregate consumption into durables and non-durables, or consider financial variables, this literature is of limited relevance.

There is also a literature on the components of UK investment, but this is of little relevance for the same reason (Ball and Drake 1963b, 1964, Nobay 1967, Holden 1969, Vipond 1969). A number of studies which have analyzed UK imports and exports have the same limitations as the work on the Irish foreign sector. Scott (1963) uses an approach similar to Leser (1967a) and the studies by members of the National Institute of

Economic and Social Research are oriented to forecasting (Godley and Shepherd 1965, Major 1967). A number of studies have been oriented toward specific issues such as the effect of the special import levy (Johnston and Henderson 1967) or the pressure of demand on exports (Ball and Drake 1962).

Four studies of the UK tax structure have been done. Two examined specific taxes (Stark 1966, McLean 1970) and two were more general (Hopkin and Godley 1965, Balopolous 1967). The Hopkin and Godley study did not present an explicit model. The Balopolous study presented a macroeconometric model of the United Kingdom designed to analyze fiscal policy.

> The model contains fourteen stochastic relationships, three special equations (consumption function, personal income tax liability and the taxes on expenditure equation) computed outside the model, and eight definitional equations. These relationships determine the values of twenty five endogenous variables given the value of fourteen instruments of fiscal policy and fifteen predetermined variables. In cases where the model deals with fiscal policy problems formulated in an indirect way, we may add to the previous relationships several constraints imposed in the form of consistency restrictions (the values of instruments of fiscal policy cannot be negative) or boundary restrictions.... (Balopolous 1967, p. 183).

To analyze the basic structure of the model, define the following variables:

Y = gross national product at factor cost

C = consumer expenditure

I = private productive investment

ΔSt = change in the value of stocks and work in progress

X = exports of goods and services

M = imports of goods and services

TE = taxes on expenditure

S = subsidies

G = government purchases

O = other final demand (private housing and government investment)

PFY = personal factor income

IB = national insurance benefits

IN = national insurance contributions

P = consumer price index

Z_i = various fiscal policy instruments i = 1,2,3,4

KSt = stock of inventories

RPM = relative price variable for imports

F = temperature

D = private capital consumption

TPY = personal income tax liability

The basic structure for the model is

$$Y = C + I_p + St + X - M - TE + \Delta S + G + O$$

$$C = f(PFY, IB, IN, P, C_{-1}, T, Z_1)$$

$$Ip = \alpha_o + \alpha_1(Y - G) + \alpha_2(Y - G)_{-1} + \alpha_3 Z_2$$

$$ST = \beta_o + \beta_1 Y + \beta_2 KSt_{-1} + \beta_3(P/P_{-1}) + \beta_4 M$$

$$M = \gamma_o + \gamma_1(Y - G) - \gamma_2 RPM + \gamma_3 \Delta St$$

$$TPY = g(PFY, t, Z_3)$$

$$TE = h(C, Y, P, F, Z_4)$$

$$D = \varepsilon_o + \varepsilon_i K + \varepsilon_2 Z_5$$

The model also includes two other tax functions (one for import taxes and one for "other" taxes), two price equations, a wage equation, three employment equations, an equation for personal factor income and an equation for national insurance contributions.

The model was linearized and estimated by two stage least squares for the years 1949-60.

> The results obtained seem to be satisfactory from the statistical point of view. The proportion of total variation explained in the most crucial relationship is very high, and the hypothesis of first order non-autocorrelation is not rejected at the 5 per cent level.... The computed standard errors of coefficients are in most cases a small fraction of the computed values of the coefficients. Finally, in all cases the coefficients take the correct sign and their values are not inconsistent with a priori expectations (Balopolous 1967, p. 183)

A number of qualifications should be noted however. Twelve observations provide the basis for the seventeen structural relationships and taking predetermined variables into account, many of the structural equations contain a large number of explanatory variables. Thus the high value of R^2 must be interpreted with caution. The implications of mixing simultaneous and non-simultaneous estimation techniques are obscure, also.

With regard to the specification of the equations, two contain time trends, the inclusion of which is a dubious theoretical procedure, in the opinion of this researcher. The specification of the investment function implies a fractional lag in the impact of changes in output on investment, whereas most studies specify a lag structure of at least 18 months (Jorgenson and Stephenson 1967, Eisner 1967, Evans 1969, p. 104). The failure to include a capital stock term is also a weakness. The disaggregation of investment into government and private is understandable for tax analysis but does not necessarily imply that government investment is exogenous.

Care must always be exercised in ascribing causality to a regression, particularly in a simultaneous system. Yet the import function which includes stocks as an "explanatory" variables and the stocks function which includes imports as an "explanatory" variable may be open to methodological criticism. Surely the relationship goes from one to the other or from some third variable to both. If this is so, then some misspecification is evident.

CHAPTER IV. A QUARTERLY MACROECONOMETRIC MODEL OF THE ANGLO-IRISH ECONOMY

Up to this point, it has been decided to estimate a quarterly macroeconometric model of the Anglo-Irish economy in the national accounts framework with a relatively disaggregated foreign sector designed to show how fluctuations in the United Kingdom are transmitted to Irish macrovariables.

The feedback of changes in Irish economic activity to UK macrovariables can be neglected because Ireland only accounts for about two per cent of UK exports. Thus, Ireland may be viewed as a small region of the British economy with an unusual degree of political autonomy.

The flow diagram presented in Figure 1 shows the direction of causality, as envisaged by this researcher. Along the horizontal axis time is measured and three discrete segments (t - 1, t, t + 1) are selected for the purposes of exposition. Irish endogenous variables at time t are the key variables to be explained by the model. They depend on their lagged values, on Irish exogenous variables and on UK endogenous variables. The UK endogenous variables depend on their own lagged values and on the variables exogenous to the UK economy. No arrow ever goes from an endogenous variable to an exogenous variable by definition and the feedback arrow from Irish endogenous variables to UK endogenous variables is assumed to be negligible and therefore omitted.

Implicit in the flow diagram is a conception of a quarterly macroeconomic model as dynamic. This researcher is obviously oriented towards structural equations some of whose explanatory variables are lagged endogenous variables. There is no a priori reason why lagged exogenous

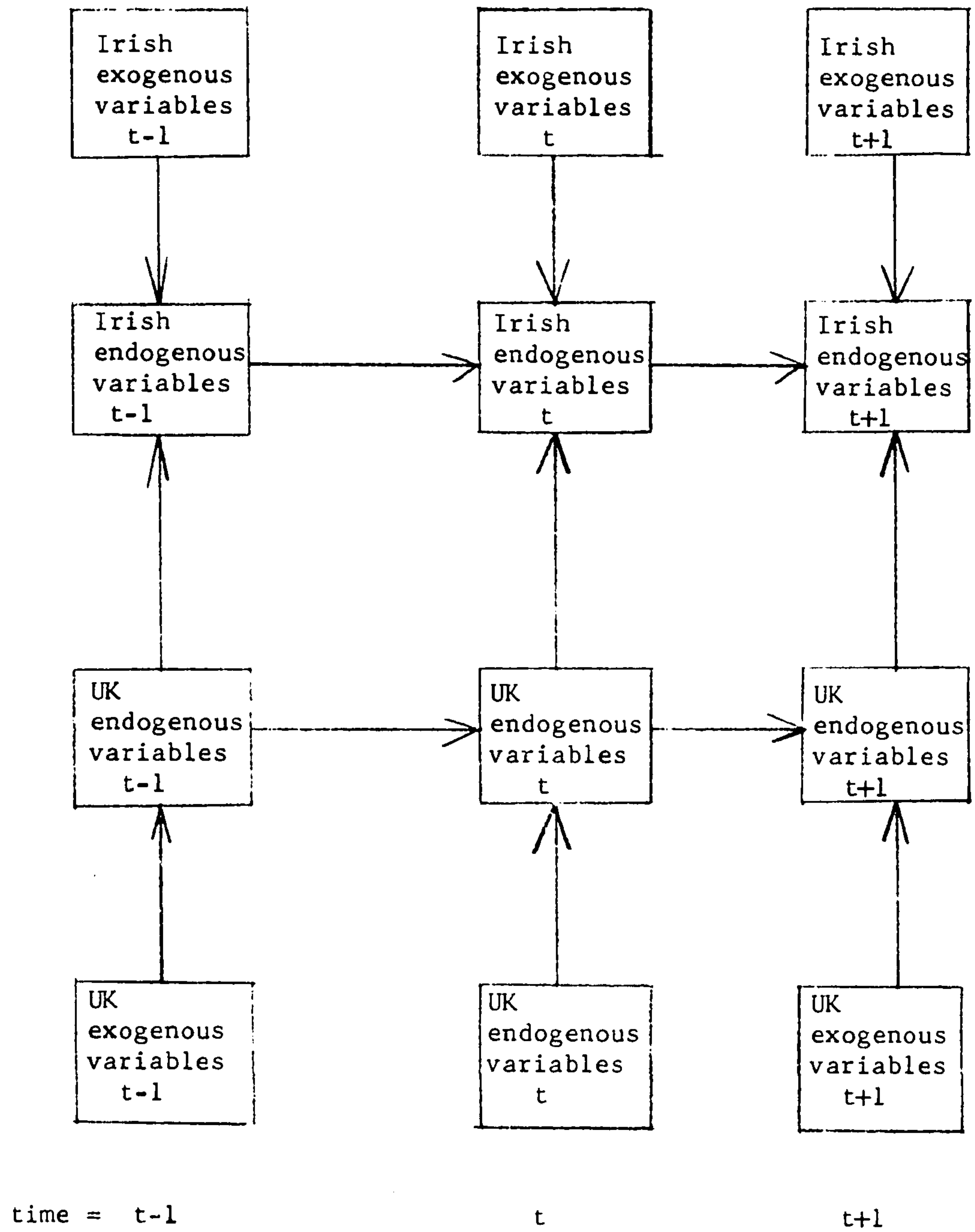

Figure 4.1. Flow diagram of the framework of a model of the Anglo-Irish economy

variables should not be included in the structural equations, although this researcher did not do so.

The particular lag structure implied by the flow diagram stems from the observation on the part of this researcher of inertia in seasonally adjusted quarterly series of endogenous variables. It is this common smoothness or inertia which leads the researcher to suspect that the series may be interrelated in a simultaneous system, and it is the roughness of many exogenous series which suggests their exogeneity. The implication of the smoothness of the series for the behavior of economic micro-units may be habit persistence, that is slow adjustment to a changing environment.

Within the framework outlined in the flow diagram, the model was specified subject to certain constraints. First, the transmission of economic fluctuations from the UK to Ireland may occur through several transmission mechanisms. In order to keep the model of manageable size only one mechanism was allowed to play a role, transmission via trade flows. Transmission can and probably does occur also through invisible exports, financial flows, factor movements and import prices. The choice of the trade flows mechanism was dictated by the availability of data. The failure to consider the other mechanisms should be borne in mind when the results of the model are evaluated.

United Kingdom residents account for 77% of Irish tourism receipts. These receipts play an important part in financing the Irish trade deficit. The stagnation of these receipts since 1968 has been a serious constraint on the growth of the economy.

The net capital inflow in the balance of payments also plays a significant role in financing the Irish trade deficit. Little has been published about the Irish capital account but it is likely that financial variables influence capital movements. Thus transmission via financial flows undoubtedly influences the Irish economy.

The bulk of Irish emigrants go to the United Kingdom and there is reason to believe that less emigration occurs when jobs are relatively scarce in that country. There is also some feeling in Ireland that Irish skilled labor responds to wage differentials between the two countries.

Finally, given the importance of the United Kingdom as a source of imports it is likely that changes in the UK price level are transmitted to the Irish price level via changes in import prices. Or course changes in factor prices which may be transmitted via factor movements will also transmit price changes from the UK to Ireland. This illustrates the interrelatedness of the various transmission mechanisms so that the model presented in this chapter not only excludes four other transmission mechanisms but ignores their interactions with the mechanism included (trade flows).

Viewed as a transmission via trade flows model, the model presented in this chapter is still incomplete. Irish exports of producers durables to the UK are exogenous because of their erratic nature. More serious, Irish exports of live animals are also exogenous. The importance of these exports cannot be overemphasized and future research must correct this deficiency of the model. Three reasons led to their exogeneity.

First, they are likely to be sensitive to changes in Irish economic conditions which are ignored by the model. The supply side of Irish exports is not considered nor is Irish agricultural policy. Second, there is evidence that the breakdown of Irish exports of live animals varied considerably during the sample period. In particular the shares of store and fat cattle exports fluctuated. Thus this component of Irish exports would have to be disaggregated further. Third, changes in UK agricultural production and policy were not allowed for in the model. In addition, other UK variables and policies may affect Irish cattle exports and were excluded. Many Irish cattle are bought on credit so that UK monetary policy has some influence. This is an example of an interaction between the trade and financial flows transmission mechanisms.

Two other constraints were imposed a priori on the model. The first was a decision to make prices exogenous and to ignore the fact that different deflators are used for the components of the national accounts. The reluctance to include a price transmission mechanism was one reason for this decision. Another was the problem of handling prices in the foreign sector where unit value indices should be used as deflators and wholesale price indices in the relative price terms. The suspicion attached to the accuracy of these prices has been mentioned above. Furthermore to make prices endogenous would entail the addition of several nonlinear relationships. Finally, the macroeconomic theory of the determination of aggregate price levels is unsatisfactory, in the opinion of this researcher. The usual procedure is to use mark-up equations where prices are expressed as functions of, among other things, unit labor costs. The likelihood of a transmission mechanism via labor movements would thus introduce another transmission mechanism. For these reasons prices were made exogenous to the model.

The final constraint on the specification of the model was due to a methodological principle favored by the researcher. It was decided, as far as possible, to derive the structural relationships from micro-economic theory. This approach appears to be favored by a large number of econometricians if their attempts to use micro theory can be adduced as evidence of their point of view. Nevertheless, it should be mentioned that this approach leads to aggregation problems which are frequently solved by being ignored. In addition the assumptions of the micro theory used are sometimes highly restrictive. Yet the position is held that it is better to derive structural relationships based on a restrictive micro theory and ignoring the problems of aggregation, than to search for significant empirical relationships and then apply a "rationale" to the result.

The Structural Equations

A convenient starting point for presenting the model are the GNP identities for both countries:

$$GNP = C + I - MC - MPN - MPD - MS + XCUK + XPNUK + A \qquad (I.1)$$

$$GNP = C + I - MC - MPN - MPD - MS + B \qquad (I.2)$$

where (I.1) refers to Ireland and (I.2) refers to the UK. The variables, all seasonally adjusted at annual rates in constant (1963) prices, are defined as follows:

GNP = gross national product

C = personal expenditure on consumer goods and services

I = gross domestic physical capital formation

MC = imports of consumer goods

MPN = imports of producer nondurables

MPD = imports of producer durables

MS = imports of services

XCUK = Irish exports of consumer goods to the UK

XPNUK = Irish exports of producer nondurables to the UK

A = other Irish final demand (government purchases, other exports to the UK such as cattle and producer durables, exports of goods to the rest of the world, exports of services)

B = other UK final demand (government purchases and exports)

The Irish data was converted to 1963 prices by setting the average of the 1963 implicit price deflator = 100.

The two identities make clear the disaggregation used. Imports are disaggregated into consumer, producer nondurable, producer durable goods and services. Irish exports are disaggregated into consumer and producer nondurable goods sold to the UK and all other exports. No disaggregation is made of consumption or investment.

The consumption function

The consumption function as used in macroeconometric models stems from work of Keynes (1936). He defined the consumption function as the functional relationship between real income and real consumption:

$$C = C\ (Y) \qquad (1)$$

He did not derive (1) from consumer theory merely asserting that "the amount that the community spends obviously depends on its income" (Keynes, pp. 91-92). Both C and Y were measured in wage units, that is, in real terms. The income variable Keynes had in mind would nowadays be called personal disposable income (Keynes, pp. 92, 94, paragraphs (2) and (5)). The "normal shape" of the function C(Y) was assumed to follow

> the fundamental psychological law, upon which we are entitled to depend with great confidence both a priori from our knowledge of human nature and from the detailed facts of experience, is that men are disposed, as a rule and on the average, to increase their consumption as their income increases but not by as much as the increase in their income (Keynes 1936, p. 96).

This amounted to restricting the derivative of C with respect to Y, called the marginal propensity to consume, to be in the open interval (0,1). Keynes noted that dc/dY will be smaller in the short run than in the long run because

> habits, as distinct from more permanent psychological propensities, are not given time enough to adapt themselves to changed objective circumstances. For a man's habitual standard of life usually has the first claim on his income, and he is apt to save the difference which discovers itself between his actual income and the expense of his habitual standard; or if he does adjust his expenditure to changes in his income, he will over short periods do so imperfectly. Thus a rising income will often be accompanied by increased saving, and a falling income by decreased saving, on a greater scale at first than subsequently (Keynes, p. 97).

Finally, Keynes suggested that even in the long run the proportion of Y consumed would decline as Y increased. This he also claimed to be "obvious" on the basis of psychology although he did not claim it to be a fundamental psychological law:

> it is also obvious that a higher absolute of income will tend, as a rule, to widen the gap between income and consumption. For the satisfaction of the immediate primary needs of a man

> and his family is usually a stronger motive than the motives toward accumulation, which only acquire effective sway when a margin of comfort has been attained. These reasons will lead, as a rule, to a greater proportion of income being saved as real income increases (ibid., p. 97).

Thus Keynes believed that the marginal propensity to consume dc/dY is less than the average propensity C/Y.

Ignoring Keynes' distinction between the short and long run marginal propensity to consume, consumption can be taken to be a function of current income. Then a function satisfying Keynes' restrictions is readily found to be

$$C = a + bY \qquad 0 < b < 1 \qquad a > 0 \tag{2}$$

Several researchers estimated consumption functions of form (2) in the ten years following Keynes' General Theory (1936) and concluded that (2) fit the data very well. (For example, Haavelmo 1947.) The function was estimated using data supplied by budget studies and annual national accounts data from 1929 on for the United States.

In 1945 a consumption function of the form (2) was used by several researchers to forecast postwar consumption (Smithies 1945, Livingston 1945, and Mosak 1945). According to Evans (1969)

> In this first attempt to predict gross national product with an aggregate consumption function, different levels of government expenditure and investment were assumed.... Typical of the predictions was the one that investment would have to be 2½ to 3 times its 1941 peak in constant dollars if the economy were to remain at full employment. All predictions were expressed in constant dollars, as inflation was not considered to be an immediate threat. In fact both 1946 and 1947 investment were only 1.1 times the 1941 level, and early postwar government expenditures were below 1941 levels (all comparisons in constant dollars). However total aggregate demand was large enough not

> only to ensure full employment but to cause substantial inflation, because the level of consumption was far above that predicted by the -- consumption function (Evans 1969, p. 15).

It was because of this divergence between prediction and outcome that Modigliani and Brumberg said "the study of the consumption function has undoubtedly yielded some of the highest correlations as well as some of the most embarrassing forecasts in the history of economics" (1954, p. 388).

One study in the decade after the General Theory had conflicted with Keynes' specification of the consumption function. This was the study by Kuznets wherein he provided estimates of the national income and expenditure for the United States for 1869-1929 (1942, p. 30). One of the remarkable features of this data was the constancy of the average propensity to save (or consume). This finding was later verified by Goldsmith who stated that a "main enduring characteristic" of saving was the "long term stability of aggregate personal saving at approximately one-eighth of income" (1955, p. 22).

There thus appeared to be some grounds for questioning Keynes' assertion that the average propensity to consume declines as income increases. If the average propensity to consume is constant then the consumption function will be linear but without an intercept term:

$$C = kY \qquad 0 < k < 1 \tag{3-4}$$

Projections of consumption on the basis of (3) rather than (2) will be higher, so that the embarrassing forecasts of 1946-47 can be avoided.

Yet (3) can only be accepted if the high correlation yielded by

(2) for budget data or short run data can be explained away. Two hypotheses have been developed which do this: the relative income hypothesis whose chief exponent was Duesenberry (1949) and the permanent income hypothesis developed independently by Modigliani and Brumberg (1954) and Friedman (1957). Only the permanent income hypothesis is discussed here.

According to the theory of intertemporal resource allocation, the individual makes his consumption decision in any time period on the basis of his current receipts, his expected future receipts and his preferences for consumption in different periods. Assume that the individual in time period 1, the period for which he must make the decision, believes he knows with complete certainty the interest rate, his future receipts and future prices. Assume that the individual wants to maximize

$$u = u(c_1, c_2, \ldots., c_T) \tag{5-6}$$

a well-defined utility function which expresses his utility in time period 1 as a function of his planned consumption throughout his T period planning horizon.

Any future consumption the consumer plans to make will reduce this maximum consumption in period 1 by the size of the loan he can no longer borrow. If he plans to consume C_t during t, then his maximum consumption during 1 is reduced by the size of the loan he can borrow on C_t (during 1). This amounts to $(1 + i)^{1-t} C_t$. If he plans to consume $C_2 \ldots. C_t$ in the future, this will reduce his maximum possible consumption in period 1 by $\sum_{t=2}^{T}(1+i)^{1-t} C_t$. Thus his maximum possible consumption in in period 1 is

$$C_1 = W_1 - \sum_{t=2}^{T} (1 + i)^{1-t} C_t \tag{7}$$

This is the budget constraint subject to which (5) is maximized. In a special sense it says that the consumer cannot plan to consume more than his wealth. Forming the Lagrangean and differentiating yields tangency and budget exhaustion conditions which are generalizations of the usual consumer theory results.

The coefficients of the C_t in the budget constraint are equal to the marginal rates of substitution of present for future consumption. The permanent income hypothesis of Friedman, Modigliani and Brumberg assumes that the utility function (5) is homogeneous so that the marginal rates of substitution are proportional to the ratio of present to future consumption. Thus (7) becomes

$$C_1 = W_1 + C_1 \sum_{t=2}^{T} K_t(i) \tag{8}$$

where K_t is the proportionality coefficient. Solving for C_1 gives

$$C_1 = K(i)\ W_1 \tag{9}$$

But income is the amount of wealth which can be consumed without diminishing the level of wealth by the next period; it is in fact equal to the interest on wealth (Hicks 1936, p.172).

$$Y_1 = i\ W_1$$

so that the consumption function becomes

$$C_1 = k(i)\ Y_1 \tag{10}$$

which is a proportional consumption function of form (3). While there is no a priori reason why the utility function should be homogeneous, there is no a priori reason why it should not be so (Friedman 1957, p. 13). Friedman would therefore justify the assumption of homogeneity on the grounds that the derived (proportional) consumption function fits the data best.

In the very long run, proponents of the permanent income hypothesis argue that the correct functional form for the consumption function is (3). In the short run, (3) should not be fit to the data directly because measured income in the short run is not an accurate proxy for permanent income. Friedman assumes that in the short run permanent income is a distributed lag of past measured incomes so that

$$C = k_1 Y + k_2 Y_{-1} + k_3 Y_{-2} + k_4 Y_{-3} + \ldots. \tag{11}$$

Assuming that the weights assigned to past values of y decline geometrically, the Koyck (1954) transformation can be applied to give

$$C = bY + dC_{-1} \tag{12}$$

This is the consumption function specified in the Anglo-Irish model.

Given that the correct form of the consumption function is the proportional one, proponents explain the observed intercept in cross-section studies on the grounds that the income variable is an inaccurate proxy for permanent income. The argument is summarized by Modigliani and Brumberg as follows

> Suppose we divide all households into three groups: (1) those whose income has increased in the current year (2) those whose income has remained the same (3) those whose income has fallen. Then unless most of the income changes just happen to be such as to return the recipients to an accustomed level from which they had previously departed, group (1) should contain a greater proportion of people with positive transitory income than group (2) and, a fortiori, group (3). Hence...households in group (1) should save, on average, a larger proportion than those in group (2) which in turn should save a larger proportion than those in group (3) (Modigliani and Brumberg 1954, p. 115).

The regression estimates using cross section data will be biased--the slope being biased downward and the intercept being biased upward.

The investment function

The theory of investment behavior dates back to the beginning of the twentieth century. At that time two approaches were adopted to explain investment behavior: the accelerator approach (Aftalion 1909) and the neoclassical approach (Fisher 1907). The conflict between these two approaches has not yet been resolved.

The earliest empirical application of the acceleration principle appears to have been Clark's (1917) study of investment in railroad cars. In its simplest form the "naive" or "rigid" accelerator hypothesizes that businessmen operate on the basis of a rule of thumb: they maintain a constant capital output ratio v so that

$$K = vQ \tag{13}$$

where K represents the capital stock and Q represents output. Net investment is the time rate of change of the capital stock so that differentiation of (13) with respect to time yields the investment function

$$\frac{dk}{dt} = I = v\,\frac{dQ}{dt} \tag{14}$$

The early writers were aware of the limitations of this investment function. Clark noted that (14) is an equilibrium relationship - disequilibrium would occur if the businessman had excess capacity or if bottlenecks in the capital goods industry forced businessmen to operate at less than desired capacity. In either case, investment would be less than v dQ/dt. In spite of these well known weaknesses, the acceleration principle enjoyed great popularity. It was not until the 1950's that the function (14) was modified to take account of its weaknesses (Goodwin 1951, Chenery 1952, Koyck 1954). The "rigid" accelerator became replaced by the "flexible" accelerator as derived from a "stock adjustment" model. Businessmen are assumed to have a constant desired capital (K*) output ratio v* so that

$$K^* = v^* Q \tag{15}$$

Then investment is assumed to be a constant proportion of the difference between the desired and actual levels of the capital stock:

$$I = u(K^* - K_{-1}) = uv^* Q - uK_{-1} \tag{16}$$

Investment is therefore a function of the level of output rather than first differences of output. Equation (16) is known as a flexible accelerator investment function.

The neoclassical approach to investment behavior is based on a theory of optimal capital accumulation (Jorgenson 1967). Such a theory is summarized as follows:

> The firm maximizes the utility of a consumption stream subject to a production function relating the flow of output to flows of labor and capital services. The firm supplies capital services to itself through the acquisition of investment goods; the rate of change in the flow of capital services is proportional to the rate of acquisition of investment goods less the rate of replacement of previously acquired investment goods. The results of the productive process are transformed into a stream of consumption under a fixed set of prices for output, labor services, investment goods and consumption goods.... Under these conditions the problem of maximizing utility may be solved in two stages. First a production plan may be chosen so as to maximize the present value of the productive enterprise. Secondly, consumption is allocated over time so as to maximize utility subject to the present value of the firm (Jorgenson 1967, p. 213).

Assuming, for simplicity, a production process with a single output, (Q) and two variable inputs labor (L) and investment in durable goods (I) where p, w, and q are the corresponding prices, then the flow of net receipts at time t, R(t) is given by

$$R(t) = p(t)Q(t) - w(t)L(t) - q(t)I(t) \tag{17}$$

Assuming, again for simplicity, that the time rate of discount is a constant (r) then the present value of the firm (PV) is

$$PV = \int_0^\infty e^{-rt} R(t)\, dt \tag{18}$$

This must be maximized subject to the two constraints mentioned above

$$\frac{dk}{dt} = I(t) - D(t) \tag{19}$$

$$F(Q(t), L(t), K(t)) = 0 \tag{20}$$

If depreciation D(t) is assumed to be proportional to the capital stock and if the production function F is a Cobb Douglas, then the marginal productivity condition for capital services is

$$\frac{Q}{K^*} = \alpha \frac{c}{p} \tag{21}$$

where α is the elasticity with respect to the input of capital services, K^* is desired capital and c can be interpreted as the implicit rental price for capital services supplied by the firm to itself (ibid., pp. 219-220). Solving for the desired capital stock yields

$$K^* = \alpha \frac{P}{c} Q = v(\frac{P}{c}) Q \tag{22}$$

Thus the chief difference between the neoclassical and accelerator theories of investment is the dependence of the neoclassical desired capital output ratio on a relative price term $(\frac{P}{c})$. Indeed, in a macro investment function, the difference amounts to using different price deflators for the national output variable. Given the decision not to make prices endogenous in the model of the Anglo-Irish economy, the two theories imply the same specification of a desired capital stock function, (15) and (22).

Once the desired capital stock function has been selected two decisions remain to be made before the specification of an investment function is complete: the functional relationship between the desired capital stock and investment must be specified and the lag structure (if any) must be chosen.

Goodwin (1951), Chenery (1952) and Koyck (1954) made net investment proportional to the deviation of the actual from the desired capital stock

$$I_t = u\ (K^*_t - K_t)\ . \tag{23}$$

Jorgenson and Stephenson (1967, p. 179) showed that this was a special case of

$$I_t = \frac{W(E)\ (1-E)}{1-E\ W(E)}\ (K_t^* - K_t) \tag{24}$$

where E is the lag operator ($E^n x_t = x_{t-n}$) and W(e) is the lag generating function, a polynomial in E so that each term is of the form $a_n E^n x_t$ (Griliches 1967). Thus $W(E)x_t$ is a shorthand notation for a distributed lag in x_t. In the special case of a distributed lag whose weights decline geometrically over time the lag generating function is

$$W(E) = \frac{1 - \lambda}{1 - \lambda E} \tag{25}$$

which makes (24) simplify to (23) with $1 - \lambda = u$.

The Jorgenson Stephenson formulation is derived in the following manner. In every period investment expenditures is a weighted average of the level of projects initiated in all previous periods:

$$I_t = W(E)\ I_t^N \tag{26}$$

where I_t^N is the value of new investment projects initiated in period t. The form of W(E) is

$$W(E) = u_o + u_1 E + u_2 E^2 + \ldots. \tag{27}$$

where u is the proportion of investment projects initiated in period t and completed in period $t + \tau$. This implies, for example, that the uncompleted proportion of investment projects at time t which were initiated in period t-3 is $(1 - u_o - u_1 - u_2)\ I_{t-3}^N$. The backlog of uncompleted projects at the beginning of period t is the sum of the uncompleted portions of previously initiated projects, and this in turn is equal to the difference between desired and actual capital:

$$I_t^N + (1 - u_o)I_{t-1}^N + (1 - u_o - u_1)I_{t-2}^N + \ldots = K_t^* - K_t. \qquad (28)$$

Algebraic manipulation of the left hand side of this expression yields:

$$K_t^* - K_t = \frac{1 - E\,W(E)}{1 - E}\, I_t^N \qquad (29)$$

which can be solved for I_t^N

$$I_t^N = \frac{(1 - E)(K^* - K)}{1 - E\,W(E)} \qquad (30)$$

Substitution of (30) into (26) gives (24) and substitution of (25) into (24) gives (23).

In the Anglo-Irish model it is assumed that investment in period t is a function of a distributed lag of previous deviations of actual from desired capital stock to avoid the first differences arrived at by Jorgenson and Stephenson:

$$I_t = W(e)\ (K_t^* - K_t)\ . \qquad (31)$$

The form of the lag generating function is postulated to be geometric (27) so that (31) is rewritten

$$I_t = \frac{1 - \lambda}{1 - E}\ (K_t^* - K_t) \qquad (32)$$

which in turn is

$$I_t = I_{t-1} + (1 - \lambda)\ (K_t^* - K_{t-1})\ . \qquad (33)$$

Then the desired capital stock is assumed to be proportional to output Q_t so that (33) is rewritten

$$I_t = I_{t-1} + (1 - \lambda)vQ_t - (1 - \lambda)\, K_t\ . \tag{34}$$

Since the theory is usually specified in terms of net investment, but the investment function is usually estimated using gross investment then depreciation must be added to both sides. If depreciation is assumed to be proportional to the capital stock

$$D_t = \delta K_{t-1} \tag{35}$$

then (34) can be written

$$I_t = I_{t-1} + (1 - \lambda)vQ_t - (I - \lambda - \delta)K_{t-1} - \delta K_{t-2} \tag{36}$$

where I_t, I_{t-1} now refer to gross investment. The multicollinearity between K_t and K_{t-1} is likely to be severe and so the term δK_{t-2} was dropped from the specification. Thus the specification chosen was

$$I_t = \beta_1 I_{t-1} + \beta_2 Q_t - \beta_3 K_{t-1} \tag{37}$$

Even this specification, as will be seen below, led to multicollinearity because of the high intercorrelation of GNP and K. A possible way around this problem is to replace Q_t by ΔQ_t, a formulation which can be justified by the modern accelerator approach of Eisner (1967) or the neoclassical approach of Jorgenson and Stephenson (1967). Yet if X_t has an error of measurement of E_t and X_{t-1} has an error of measurement of E_{t-1}, then X_t can have an error of measurement as large as $E_t + E_{t-1}$. If the errors are suspected of being large first differences are precluded. As mentioned in the last chapter first differences of Irish annual data fluctuate to a fantastic degree and since the Irish quarterly data are more subject to error than the annual figures, it was decided not to use first differences.

The behavioral basis for (37) is habit persistence. Businessmen do not react to deviations of desired from actual capital stock very rapidly. The deviations must persist for a number of time periods before action is taken. With future improvements in Irish quarterly national accounts a more satisfactory investment function can be specified.

One problem remains for the investment function specified in (37). No time series on the capital stock is available for either the United Kingdom or Ireland. It has been shown, however, that cumulation of net investment around an arbitrary origin is an acceptable approximation to the capital stock (Ball and Drake 1963b). Consider the cumulation of net investment from the first quarter of 1961. The capital stock at time t is

$$K_t = \sum_{\tau=-\infty}^{1960\ \mathrm{IV}} I_{n\tau} + \sum_{\tau=1961\ \mathrm{I}}^{t} I_{n\tau} \tag{38}$$

where $I_{n\tau}$ is net investment at time τ. The first term on the right hand side is the value of the capital stock at the end of 1960 and is a constant. Now consider a regression where the capital stock enters as an explanatory variable

$$Y_t = a_o + a_1X_t + a_2K_t \tag{39}$$

Substitution of (38) for K_t yields

$$Y_t = (a_o + a_2\sum_{\tau=-\infty}^{1960\ \mathrm{IV}} I_{n\tau}) + a_1X_t + a_2 \sum_{=1960\ \mathrm{I}}^{t} I_{n\tau} \ . \tag{40}$$

Since the second term is a constant (40) may be rewritten

$$Y_t = b_o + a_1 X_t + a_2 \sum_{\tau=1960}^{t} I_{n\,I} \tau \; . \qquad (41)$$

Estimation of (41) by regression, therefore, will provide estimates of a_1 and a_2 but the intercept term will be observed subject to error. Since the intercept term is not usually of direct interest to the model builder, cumulation around an arbitrary origin provides an acceptable proxy for the capital stock. The chief result is the inclusion of an intercept term in the investment function, so that the specification finally chosen was:

$$I_t = -\beta_o + \beta_1 I_{t-1} + \beta_2 GNP_t - \beta_3 K_t . \qquad (42)$$

Import and export functions

The theoretical specification of the import functions used in the Anglo-Irish model views them, in essence, as demand functions. The purchaser of an import is regarded as a consumer making a choice between two commodities: an import and its domestic substitute. Denoting the import quantity by M and the quantity of the domestic substitute by H, the consumer is assumed to have a well-defined utility function

$$u = u\ (M,\ H)\ . \qquad (43)$$

The importer is assumed to want to maximize (43) subject to a budget constraint. The form of the budget constraint is that the sum of the purchases from the two sources of supply not exceed the total purchases of the commodity:

$$P_M\, M + P_H \cdot H \leqq P_T \cdot T \quad . \qquad (44)$$

Thus, in the case of consumer goods T = C and in the case of producers durables T = I. This assumes all consumer and investment goods can be purchased at home or abroad. This assumption could, in principle be relaxed. Forming the lagrangean and differentiating, import demand functions can, in principle, be derived:

$$M = f(\frac{P_M}{P_H} \mid T,\ u) \quad . \tag{45}$$

The demand functions are sets of ordered pairs of observations on $(M,\ P_M/P_H)$ assuming a certain level of total expenditure (T) and given preferences (u). The prices are expressed as a ratio because of the homogeneity postulate (Allen 1966, p. 658).

The demand function (45) must be modified before it can be estimated. The functional form must be specified and for the Anglo-Irish model it is assumed to be linear. Even then the function cannot be estimated from time series because at least T, and maybe u, are changing as the observations on M are changing. Thus "statistical" demand functions have the general form

$$M = f(P_M/P_H,\ T,\ u) \ . \tag{46}$$

Finally the function may be generalized to include lagged values of the dependent variable on the same kind of rationale as supplied by Friedman for the inclusion of C_{-1} in the consumption function: M is a function of a distributed lag of P_M/P_H and T which are interpreted as permanent prices and expenditures. Consumers only gradually change M in response to changes in P_M/P_H and T.

Two import functions were derived from this framework

$$MC = \gamma'_o + \gamma'_1 MC_{-1} + \gamma'_2 C - \gamma'_3 RPMC \tag{47}$$

$$MPD = \delta_o + \delta_1 MPD_{-1} + \delta_2 I - \delta_3 RPMPD \tag{48}$$

where the variables are defined as follows:

MC = imports of consumer goods

RPMC = relative price variable for imports of consumer goods

MPD = imports of producers durables

RPMPD = relative price variable for imports of producers durables.

The other two import functions do not fit in this framework. Two empirical-type relationships were formulated for them:

$$MPN = \varepsilon_o + \varepsilon_1 MPN_{-1} + \varepsilon_2 GNP - \varepsilon_3 RPMPN \tag{49}$$

$$MS = \zeta_o + \zeta_1 MS_{-1} + \zeta_2 GNP \tag{50}$$

where the variables are

MPN = imports of producer nondurables

RPMPN = relative price variable for imports of producer nondurables

MS = imports of services.

The two export functions in the model are derived in a similar manner to the derivation of the import functions above. The British importer is regarded as a consumer choosing between two sources of supply: Ireland and the rest of the world. Let IXUK be the quantity purchased from Ireland and MRW be the quantity imported from the rest of the world. Then the consumer is assumed to allocate his expenditure between the two sources of supply so as to maximize a utility function

$$u = u\ (IXUK,\ MRW) \tag{51}$$

subject to a constraint

$$P_I \cdot IX\ UK + P_{RW} \cdot MRW \leq P_M \cdot M \tag{52}$$

that the value of purchases from Ireland and the rest of the world not exceed the value of imports. Demand functions can be derived of the general form

$$IX\ UK = f(\frac{P_I}{PRW} \Big/ M,\ u) \tag{53}$$

which can be modified to include the movements in M and u and to include lagged values of the dependent variable. Again the functional form f is assumed to be linear. Two export functions were specified:

$$XC = \eta_o + \eta_1 XC_{-1} + \eta_2\ UMC - \eta_3\ RPMC \tag{54}$$

$$XPN = \theta_o + \theta_1 XPN_{-1} + \theta_2 UMPN - \theta_3 RPMPN \tag{55}$$

where the variables were defined to be

XC = Irish exports of consumer goods to the UK

UMC = UK imports of consumer goods from the world

RPMC = relative price variable from Irish exports of consumer goods

XPN = Irish exports of producers' nondurables to the UK

UMPN = UK imports of producers' nondurables

RPMPN = relative price variable for Irish exports of producers' nondurables.

The special nature of Irish exports of producers' durables (the erratic movements of ships and boats) led the researcher to make them exogenous to the model.

Before leaving the specification of the foreign sector two limitations of the import functions should be noted. First, imports are assumed to be completely determined by demand conditions - supply conditions are neglected. Attempts to build supply conditions into models of imports have not been notably successful (Leamer and Stern 1970, p. 7). Nevertheless, supply conditions must exert some influence. Second, many specifications of quarterly import functions include cyclical or capacity utilization indicators. Changes in inventories are often included but could not be used in this study because of lack of (Irish) data. Baker and Durkan (1970c) experimented unsuccessfully with an index of capacity utilization in their import functions. This researcher is not convinced of the need for such devices. Although the weaknesses of unit value indices may support such a formulation, it would appear that correctly formulated import functions in a simultaneous macroeconometric model, should take account of cyclical influences. An index of capacity utilization should be an endogenous variable in a macromodel and could and should be replaced in an import function by its explanatory variables.

Tax functions

Only two other structural equations were specified to the model of the Anglo-Irish economy. Both of these were tax functions and both were essentially empirical rather than behavioral relationships. Indirect taxes were assumed to depend on consumption expenditure and direct taxes were assumed to depend on a proxy variable for personal income:

$$TE = \kappa_o + \kappa_1 C + \kappa_2 C_{-1} \tag{56}$$

$$TY = \lambda_o + \lambda_1 PY + \lambda_2 PY_{-1} \tag{57}$$

where the variables were

TE = taxes on expenditure

TY = taxes on income.

The inclusion of the current and lagged values of the explanatory variable in the equations is a device due to Tinbergen (1939) for measuring a fractional lag (Nerlove 1964, pp. 121-122). Define

$$x_{t-\theta} = (1-\theta)x_t + \theta x_{t-1} \; . \tag{58}$$

Graphically $x_{t-\theta}$ is the linearly interpolated value between x_t and x_{t-1} at time t-θ as can be seen if the reader draws a right triangle with base time period, left vertex x_{t-1} and height Δx_t .

$$ax_t + bx_{t-1} = cx_{t-\theta} \tag{59}$$

where

$$c = a + b$$

$$\theta = \frac{b}{a+b} \; . \tag{60}$$

The Postulated Model of the Anglo-Irish Economy

The entire Anglo-Irish model consisted of 20 structural relations and ten identities determining 30 endogenous variables. Ten current exogenous variables entered the model together with 18 lagged endogenous variables making a total of 28 predetermined variables. Irish variables were prefixed by the letter l, and UK were prefixed by the letter U. The endogenous variables common to both countries were 14 in number and defined as follows:

GNP = expenditure on gross national product

C = personal expenditure on consumer goods and services

DY = personal disposable income

I = gross domestic physical capital formation

K = capital stock

MC = imports of consumer goods

MPD = imports of producers' durable goods

MPN = imports of producers' nondurable goods

MS = imports of services

TE = taxes on expenditure

TY = taxes on income

PY = personal income

D = capital consumption allowances

NI = net domestic physical capital formation

Two endogenous variables were unique to Ireland.

XC = Irish exports of consumer goods to the United Kingdom

XPN = Irish exports of producers' nondurable goods to the United Kingdom.

The exogenous variables common to both countries were three in number and defined as follows:

RPMC = relative price variable for imports of consumer goods

RPMPD = relative price variable for imports of producer durable goods

RPMPN = relative price variable for import of producers' nondurable goods

Two exogenous relative price variables were unique to Ireland.

RPXC = relative price variable for exports of consumer goods

RPXPN = relative price variable for exports of producers' nondurable goods

Both countries had one other exogenous variable called other final demand but the composition was different. In Ireland the variable was defined as

A = other final demand (including government purchases, other exports to the UK such as cattle and producer durables, exports of goods to the rest of the world, exports of services)

For the United Kingdom the variable was

B = other final demand (including government purchases and exports).

The structural relations of the model were numbered and the number was preceded by an I for identities and an E for equations. The model is presented below beginning with the two GNP identities followed by nine equations and four identities common to both countries, and ending with the two Irish export functions. The variable associated with each relation is isolated on the left hand side:

$$GNP = C + I - MC - MPN - MPD - MS + XC + XPN + A \qquad (I.1)$$

$$GNP = C + I - MC - MPN - MPD - MS + B \qquad (I.2)$$

$$C = \alpha_1 C_{-1} + \alpha_2 DY \qquad (E.1)$$

$$I = -\beta_o + \beta_1 I_{-1} + \beta_2 GNP - \beta_3 K \qquad (E.2)$$

$$MC = \gamma_o + \gamma_1 MC_{-1} + \gamma_2 C - \gamma_3 RPMC \qquad (E.3)$$

$$MPD = \delta_o + \delta_1 MPD_{-1} + \delta_2 I - \delta_3 RPMPD \qquad (E.4)$$

$$MPN = \varepsilon_o + \varepsilon_1 MPN_{-1} + \varepsilon_2 GNP - \varepsilon_3 RPMPN \qquad (E.5)$$

$$MS = \zeta_o + \zeta_1 MS_{-1} + \zeta_2 GNP \qquad (E.6)$$

$$TE = K_o + K_1 C + K_2 C_{-1} \qquad (E.7)$$

$$TY = \lambda_o + \lambda_1 PY + \lambda_2 PY_{-1} \qquad (E.8)$$

$$D = i_o + i_1 K \qquad (E.9)$$

$$DY = PY - TY \qquad (I.3)$$

$$NI = I - D \qquad (I.4)$$

$$K = K_{-1} + NI \qquad (I.5)$$

$$XC = \gamma_o + \gamma_1 XC_{-1} + \gamma_2 UMC - \gamma_3 RPXC \quad (E.10)$$

$$XPN = \theta_o + \theta_1 \ XPN_{-1} + \theta_2 \ UMPN - \theta_3 RPXPN \quad (E.11)$$

Inspection of the equations shows that no equation contains more than three endogenous variables. The order (necessary) condition for identification requires "the number of predetermined variables excluded from the relation to be at least as great as the number of endogenous variables included less one" (Johnston 1963, p. 251). Thus each equation should exclude at least two predetermined variables. The postulated model includes 28 predetermined variables so that the order condition for identification is easily satisfied. The model is in fact over-identified.

Estimation Procedure for the Postulated Model

Consider the simplest multiple regression model

$$Y_t = \beta_o + \beta_1 X_{1t} + \beta_2 X_{2t} + u_t \qquad t = 1,\ldots,T \quad (1)$$

where the X's are assumed to be fixed and the u_t are identically and independently distributed with zero mean and common variance. In matrix form, the T equation system is written

$$Y = X\,\beta + u \quad (2)$$

with the assumptions

$$E[u] = 0 \quad (3)$$

$$E[u\,u'] = \sigma^2 I \quad (4)$$

$$X \text{ of full rank} \,. \quad (5)$$

The least squares estimators are

$$\beta = (X'X)^{-1} X'Y \tag{6}$$

and these are best linear and unbiased. Consider the proof of their unbiasedness

$$E[\beta] = E[(X'X)^{-1}X'Y] = (X'X)^{-1}X' E[Y]$$

$$= (X'X)^{-1}X'X\beta + (X'X)^{-1}X' E[u] = \beta . \tag{7}$$

In economics, the X's are usually not fixed but generated by a stochastic process. Ignoring the need for asymptotic distribution theory, the proof of unbiasedness will still go through provided the distributions of X and u are independent so that

$$E[X'u] = 0 . \tag{8}$$

The key requirement is that the explanatory variables be independent of the disturbance term.

Consider now the simplest simultaneous system:

$$\begin{aligned} Y_{it} &= \beta_{10} + \beta_{11}X_{1t} + \beta_{12}X_{2t} + a_{12} Y_{2t} + U_{1t} \\ Y_{2t} &= \beta_{20} + \beta_{21}X_{1t} + \beta_{22}X_{2t} + a_{21} Y_{1t} + U_{2t} \end{aligned} \tag{9}$$

Substituting the right hand side of the equation for Y_{1t} into the equation for Y_{2t} and solving for Y_{2t}, and similarly substituting the right hand side of the equation for Y_{2t} into the equation for Y_{1t} and solving for Y_{it} yields a new system

$$\begin{aligned} Y_{it} &= f_1(X_{1t}, X_{2t}, U_{1t}, U_{2t}) \\ Y_{2t} &= f_2(X_{1t}, X_{2t}, U_{1t}, U_{2t}) \end{aligned} \tag{10}$$

so that Y_{it} is a function of Y_{2t} and Y_{2t} is a function of Y_{1t}. Thus ordinary least squares applied to the equations in (9) will yield unbiased estimates.

The simultaneous system in (9) can be written in matrix form as

$$AY_t = BX_t + u_t \tag{11}$$

If A is nonsingular the reduced form of the system is

$$Y_t = A^{-1}BX_t + A^{-1}u_t \tag{12}$$

It is noteworthy that (12) is not a simultaneous system so that ordinary least squares estimators are unbiased. The question arises: can unbiased estimators of (11) be derived from unbiased estimators of the coefficient matrix in (12)? The answer depends on whether (11) is identified. If (11) is not identified the answer is no, if (11) is identified the answer is yes. An identified system may be exactly identified or overidentified. If exactly identified then unique estimators of (11) can be derived from (12), and the procedure is known as indirect least squares.

Several estimation procedures have been derived for overidentified systems as is the case in the Anglo-Irish model. These fall into two groups: limited information and full information methods. They all involve different methods of going from the reduced form estimates to the estimates of the structural equations. Full information methods are efficient because they use all the information about every variable in the system to estimate each parameter; limited informations are inefficient because they only use the information about the variables in the particular equations being estimated to estimate the parameters of that equation. Limited information methods are usually used for computational simplicity and because the full information methods are very sensitive to specification error. It is only desirable to use all the information if the information is accurate, and most econometricians believe it is not.

This researcher does not believe that any one estimation method is superior in all circumstances. A number of criteria for choosing the estimation procedure might be listed.

> Unfortunately, the present stage of development of (econometrics) might be likened to a primitive stage in medicine where a doctor is able to treat only one complaint at a time: he can reset a broken arm or prescribe for influenza, but if you come to him with both these troubles at once, the poor fellow is baffled and is forced to select one of our ailments, treat that, and leave the other alone. So in econometrics we have various methods of treating problems... but the methods for handling the first problem have been developed under assumptions which rule out the possibility of the second....(Johnston 1963, p. 147).

Thus a decision to estimate a model using a simultaneous technique is a decision to treat simultaneous equation bias as the paramount estimation problem for the model under consideration. It further implies that the large sample properties are the best guide to the small sample properties of an estimator since the justification of simultaneous estimators is made on the basis of large sample theory, and since the econometrician is usually using small samples. The evidence on this latter point from Monte Carlo studies is not overwhelming (Johnston 1963, chapter 10).

This researcher decided to use ordinary least squares mainly because its computational convenience (given the constraints under which he operated) more than offset the disadvantage of the simultaneous equation bias introduced into the results. In addition there were several other estimation problems which the researcher was forced to tolerate, no matter which estimation procedure was used. Three of these may especially be mentioned. Consider again a distributed lag function

$$Y_t = W(E)\ x_t + u_t \ . \tag{13}$$

If, as in most of the equations for the Anglo-Irish model, the weights of the distributed lag are assumed to follow a geometric distribution, the lag generating function has the form

$$W(E) = \frac{1 - \lambda}{1 - \lambda E} \tag{14}$$

so that (13) can be rewritten

$$Y_t = \frac{1 - \lambda}{1 - \lambda E}\ x_t + u_t \ . \tag{15}$$

Multiplying both sides by $1 - \lambda E$ gives

$$Y_t = Y_{t-1} + (1-x)x_t + u_t - \lambda u_{t-1} \ . \tag{16}$$

Two problems are created by this transformation. The inclusion of the lagged dependent variables means that the Durbin-Watson for autocorrelation becomes meaningless and the new disturbance term is likely to exhibit such autocorrelation. The seriousness of the error cannot be judged a priori because of the lack of the Durbin-Watson test but in a sampling study (Orcutt and Cochrane 1949) found a serious bias introduced.

The situation is similar in the case of multicollinearity which may be present in the consumption and investment functions used in the model. The usual result of multicollinearity is large standard errors of the coefficients. Since large standard errors lead to low t values, the multicollinearity problem can be very serious. Yet no measure of the seriousness of the multicollinearity problem exists. Klein (1962, p. 101) suggests a "rule of thumb" that the partial correlation of any two explanatory variables should be less than the multiple correlation coefficient from the equation as a whole. Even this rule of thumb has problems, however, because it will only measure pairwise multicollinearity (Huang 1970, p. 154). No satisfying solution to the problem of multicollinearity exists either, although a number of approaches may be taken. Extraneous information might be incorporated or principal components might be used to replace the collinear variables.

Finally there is the problem of "outliers". Suppose that a simple regression is estimated and the residuals are calculated. Suppose that all the residuals are less than the standard error of estimate except one which is say six times that value. Then it is useful to plot the values to see if that observation is an outlier. If so, the particular time period associated should be examined for evidence of a special event which would account for the outlier such as a strike or the introduction of a new tax. Two procedures exist for dealing with outliers: a dummy variable might be incorporated for the special event or the time series might be adjusted so as to yield a more "normal" residual for that time period. The latter procedure was adopted in this study to avoid a large number of dummy variables and because outliers often so disturbed the relationship that the lagged dependent variable became insignificant in the regression equation. The differences between the adjusted and unadjusted time series were added to the "other final demand" exogenous variable for each country. Sometimes a component of a time series exhibited erratic fluctuations and the whole component subseries was subtracted out. Thus imports of unmilled cereals were subtracted out. Thus imports of unmilled cereals were subtracted out of Irish imports of producer nondurables (following Baker and Durkan 1969c) because such imports are allowed to fill the gap between domestic production and consumption. This gap depends mainly on the weather. Similarly imports of ships and aircraft are subtracted from imports of producers' durables (Baker and Durkan 1970a). A list of special events that disturbed the relationships postulated in the model is provided in Table 1.

Table 4.1. Special events in the Anglo-Irish economy 1961-68

Quarter		Event
1963	I	U.S. dock strike kept over 600 ships idle for 34 days
	II	Maudling expansionary budget in the UK
	III	Irish dock strike for two weeks
	IV	Irish turnover tax introduced
1965	I	UK special import levy
	IV	Irish special import levy - eliminated in stages in the latter half of 1966
1966	II	UK seamen's strike
	III	Anglo-Irish Free Trade Agreement. UK selective employment tax introduced
1967	III	Liverpool dock strike
	IV	Devaluation

The Estimated Model

The results of estimating the model as hypothesized are presented below. Four statistics are presented to the right of each equation: $\bar{R}^2$, Durbin-Watson (DW), mean of dependent (left hand side) variable and standard error of estimate (SE). Standard errors are written in parentheses below the intercepts; t values are written below the other coefficients. Five per cent critical values for 30 degrees of freedom were 2.042 for t and (1.28, 1.57) for Durbin-Watsons with two regressors and (1.21, 1.65) for Durbin-Watsons with three regressors. The intervals for the Durbin-Watsons (d_L, d_u) are defined by lower and upper bounds. If the DW is less than d_L then positive serial correlation is probably present and if it is above d_u it is probably not; within the interval the test fails. The values presented are for the case of positive serial correlation; they must be subtracted from 4 to obtain those for negative serial correlation. It should be pointed out, however, that the Durbin Watson test is only approximately applicable to simultaneous models and equations containing lagged dependent variables.

<u>Consumption functions</u>:

Irish
$$C = \underset{(5.93)}{0.6470C_{-1}} + \underset{(3.31)}{0.3277DY}$$
$\bar{R}^2 = 0.9998$ 2.24 = D.W.
c = 624.5 8.25 = S.E.

UK
$$C = \underset{(11.0)}{0.8495C_{-1}} + \underset{(2.02)}{0.1405DY}$$
0.9999 2.18
20,870.8 247.5

<u>Investment functions</u>:

Irish
$$I = \underset{(6.66)}{0.8075I_{-1}} + \underset{(2.23)}{0.2496GNP} - \underset{(1.46)}{0.0130K_{-1}} - \underset{(82.6)}{159.5}$$
0.8941 1.87
174.4 10.2

UK
$$I = \underset{(2.42)}{0.3022I_{-1}} + \underset{(5.20)}{0.5385GNP} - \underset{(3.21)}{0.0177K_{-1}} - \underset{(2.607)}{11.846}$$
0.9367 2.54
6034.0 209.3

Consumer import functions:

Irish	$MC = 0.4415MC_{-1} + 0.2000C + 0.0393RPMC - 86.6$	0.8965	2.08
	$(2.62) \quad (2.79) \quad (0.06) \quad (92.1)$	73.94	4.70
UK	$MC = 0.5258MC_{-1} + 0.0326C - 2.6361RPMC + 498.2$	0.8146	1.28
	$(3.24) \quad (2.61) \quad (0.98) \quad (302.2)$	1938.6	41.2

Producer nondurables import functions:

Irish	$MPN = 0.9162MPN_{-1} + 0.0372GNP - 0.0743RPMPN - 7.95$	0.8931	1.86
	$(4.82) \quad (0.77) \quad (0.09) \quad (89.0)$	170.6	7.42
UK	$MPN = 0.4645MPN_{-1} + 0.1051GNP + 4.4573RPMPN - 2242.7$	0.9515	1.67
	$(2.89) \quad (3.45) \quad (0.69) \quad (983.5)$	2814.5	89.6

Producer durables import functions:

Irish	$MPD = 0.1788MPD_{-1} + 0.2263I + 0.1026RPMPD + 0.57$	0.9417	1.71
	$(1.44) \quad (6.50) \quad (0.03) \quad (37.6)$	49.7	2.09
UK	$MPD = 0.9780MPD_{-1} + 0.0201I + 2.385RPMPD - 321.0$	0.9810	2.50
	$(15.27) \quad (1.65) \quad (1.50) \quad (164.0)$		

Imports of services functions:

Irish	$MS = 0.8551MS_{-1} + 0.0079GNP - 2.70$	0.9805	1.68
	$(12.70) \quad (1.83) \quad (2.29)$	25.74	0.71
UK	$MS = 0.4151MS_{-1} + 0.0287GNP + 72.0$	0.9263	0.73
	$(2.34) \quad (3.22) \quad (85.9)$	117.9	5.68

Taxes on expenditure functions:

Irish	$TE = 0.3090C + 0.1777C_{-1} - 185.1$	0.9263	0.73
	$(2.83) \quad (1.60) \quad (15.64)$	117.9	5.68
UK	$TE = 0.1906C + 0.2996C_{-1} - 5572.6$	0.8653	0.29
	$(1.12) \quad (1.78) \quad (734.4)$	4621.5	238.6

Taxes on income functions:

Irish	$TY = 0.1298PY + 0.1280PY_{-1} - 124.4$	0.9388	0.76
	$(3.81) \quad (3.68) \quad (8.99)$	68.16	3.83
UK	$TY = 0.0991PY + 0.1684PY_{-1} - 3359.2$	0.5990	0.20
	$(0.5388) \quad (0.9186) \quad (1053.8)$	3823.4	317.0

Depreciation functions:

Irish	$D = 0.0085K_{-1} + 50.23$	0.9638	0.11
	$(28.3) \qquad (0.0561)$	63.65	1.66
UK	$D = 0.0083K_{-1} + 2094.5$	0.9971	0.34
	$(101.8) \qquad (4.95)$	2524.8	14.35

Irish export functions:

Consumer goods	$XC = 0.5018XC_{-1} + 0.0549UMC + 0.3746RPXC - 112.9$	0.9050	2.29
	$(3.92) \qquad (3.59) \qquad (1.85) \qquad (29.1)$	66.55	3.96
Producer	$XPN = 0.7456XPN_{-1} + 0.0053UMPN - 0.0522RPXPN - 1.27$	0.9588	1.53
	$(5.57) \qquad (2.41) \qquad (0.63) \qquad (7.12)$	30.66	1.37

The results show the need for more experimentation. Three general conclusions emerge. First, relative price terms in the import and export functions are nowhere significant. This result is not unusual (Klein et al. 1961, Rhomberg and Boissenault 1964, McAleese 1970) and undoubtedly reflects some specification error. The functions are derived on the assumptions that imports and domestic production are substitutes, and that relative price variables are exogenous. The assumption of substitutability is little more than a crude approximation which was made because of the high level of aggregation in the model. The assumption of exogenous prices was made because of the complexity which would otherwise be introduced, as was discussed in the last chapter.

Yet the insignificance of the price variables may also be due to the considerable measurement errors present in them. These errors are likely to be magnified because the prices are expressed as ratios. Aside from the questionable appropriateness of the price indices used, they are subject to two special sources of error. First, the price index in the numerator never refers to the same basket of commodities as the price index in the denominator. Indeed some indices are formed by dividing wholesale prices by unit values. Wholesale price indices include customs duties; unit value indices do not. The question arises: do the ratios include the duties or not? Second, unit values are particularly subject to measurement errors. If they are calculated for a general category they are sensitive to its changing commodity composition; if they are calculated for a constant commodity composition, they exclude many important groups of commodities. Thus although the empirical results do not support the hypothesis that relative prices significantly affect consumer choice between imports and domestic production, these results can hardly be taken as evidence to the contrary. While price variables which accord with a priori expectations (have negative coefficients) could be left in the model, those which do not should certainly be eliminated.

The second general feature of this first estimation of the model is the poor performance of the four tax functions. In particular all Durbin-Watsons are unacceptable. These are not surprising if they indicate structural change during the sample period. Such structural change would occur if the government altered the tax system by introducing new taxes or changing existing deductions or rates. This structural change would show up in the residuals where "runs" of positive and negative values would be found. The possibility of such structural changes should be investigated.

The same type of problem appears to be present in the three functions where the values of the dependent variables were obtained by smoothly interpolating the annual figures using the Sandee-Lisman technique. (Irish imports of services and the two depreciation functions.) This technique fits a nonlinear trend to the annual data. The regression procedure assumes linearity. If the dependent variable (depreciation or service imports) follows a nonlinear trend and the independent variable follows a linear trend (GNP or capital stock), then the relationship will be nonlinear. Thus there will be evidence of structural change during the period: several linear functions should be used to approximate the nonlinear relationship. Once again the residuals should be investigated for the structural changes.

Structural changes might also affect the import functions because of the unsatisfactory performance of the price indices. If the price indices do not adequately reflect actual price changes, then the estimated import functions are likely to shift at times of major price changes. Two such changes occurred within the sample period: the imposition of special import levies by both countries in 1965-66 and devaluation at the end of 1967.

Thus, the results of the first estimation of the model suggest the elimination of the price terms from the import and export functions and the possibility of structural changes in the tax depreciation and import functions. It was decided to take account of structural change using dummy variables but the dummies utilized only shifted the intercepts of the functions and not the slopes. Dummies to allow for slope changes could be incorporated but the system would become nonlinear, and this was ruled out a priori.

The results of amending the model are presented below. Needless to say, the particular equations presented are the best results obtained after trying several alternative forms. The same four statistics are presented with each equation: $\bar{R}^2$, DW, SE, and mean of the dependent variable.

Taxes on expenditure functions:

Irish
$$\underset{(3.59)}{TE = 0.2540C} + \underset{(3.09)}{0.2215C_{-1}} - \underset{(6.39)}{8.6995Z1TE} - \underset{(10.19)}{174.55} \qquad \begin{matrix} 0.9696 & 1.64 \\ 117.9 & 3.65 \end{matrix}$$

UK
$$\underset{(3.14)}{TE = 0.1836} + \underset{(4.61)}{0.2670C_{-1}} - \underset{(10.28)}{333.1ZTE1} - \underset{(2.69)}{134ZTE2} + \underset{(7.7)}{502.8ZTE3}$$
$$- \underset{(288.5)}{4636.4} \qquad \begin{matrix} 0.9850 & 1.58 \\ 4621.5 & 79.9 \end{matrix}$$

Taxes on income functions:

Irish
$$\underset{(7.14)}{TY = 0.1438PY} + \underset{(6.45)}{0.1308PY_{-1}} - \underset{(7.12)}{6.26ZT} - \underset{(4.43)}{6.56ZTY} - \underset{(6.07)}{134.0}$$
$$\begin{matrix} 0.9793 & 2.03 \\ 68.16 & 2.23 \end{matrix}$$

UK
$$\underset{(2.43)}{TY = 0.0931PY} + \underset{(5.63)}{0.2159PY_{-1}} - \underset{(4.76)}{219.65ZTY1} - \underset{(23.53)}{792.28ZTY2}$$
$$- \underset{(15.05)}{549.74ZTY3} - \underset{(3.30)}{142.75ZTY4} - \underset{(279.1)}{4134.4} \quad \begin{matrix} 0.9837 & 1.80 \\ 3825.4 & 63.99 \end{matrix}$$

Depreciation functions:

Irish
$$D = \underset{(24.51)}{0.0080K} - \underset{(7.31}{3.96ZD1} - \underset{(2.43)}{1.43ZD2} + \underset{(0.51)}{52.20} \qquad \begin{matrix} 0.9912 & 1.02 \\ 63.65 & 0.82 \end{matrix}$$

UK
$$D = \underset{(136.1)}{0.0085K} - \underset{(3.33)}{14.66ZD1} - \underset{(7.85)}{27.90ZD2} - \underset{(4.73)}{28.63ZD3} + \underset{(3.53)}{2099.4} \quad \begin{matrix} 0.9992 & 1.57 \\ 2524.8 & 7.78 \end{matrix}$$

Irish imports of services function:

$MS = 0.5875MS_{-1} + 0.0283GNP + 1.6480ZMS1 - 1.1750ZMS2 - 13.6$	0.9879	1.42
(7.02) (4.34) (3.87) (2.35) (3.7)	25.74	0.56

Consumer import functions:

Irish	$MC = 0.4415\ MC_{-1} + 0.1970C - 80.93$	0.9002	2.08
	(2.66) (3.74) (22.34)	73.94	4.61
UK	$MC = 0.5461MC_{-1} + 0.0306C + 246.3$	0.8150	1.30
	(3.40) (2.49) (153.3)	1938.6	41.1

Producer nondurables import functions:

Irish	$MPN = 0.9082MPN_{-1} + 0.0392GNP - 15.70$	0.8970	1.87
	(5.5) (0.93) (15.75)	170.6	7.29
UK	$MPN = 0.5059MPN_{-1} + 0.0972GNP - 1659.9$	0.9524	1.69
	(3.4) (3.5) (498.8)	2814.5	88.8

Producer durables import functions:

Irish	$MPD = 0.1773MPD_{-1} + 0.2258I + 1.73$	0.9438	1.71
	(1.58) (7.53) (2.23)	49.73	2.05
UK	$MPD = 1.0287MPD_{-1} + 0.0151I - 84.64$	0.9801	2.35
	(18.48) (1.26) (47.81)	601.84	27.81

Irish export functions:

Consumer goods	$XC = 0.5910XC_{-1} + 0.0558UMC - 80.43$	0.8968	2.24
	(4.78) (3.51) (47.81)	66.6	4.12
Producer nondurables	$XPN = 0.7856XPN_{-1} + 0.0045UMPN - 5.53$	0.9597	1.59
	(6.76) (2.54) (2.10)	30.66	1.35

Dummy variables enter the four tax, two depreciation and Irish service imports functions, as expected. The symbols for the dummies begin with the letter Z. The periods for which each dummy assumes the value of unity are presented in Table 4.2. The four tax functions now appear satisfactory. All have high $\bar{R}^2$'s, acceptable Durbin-Watsons and low standard errors of estimates. All coefficients are significant at the .05 level.

The sign of one of the dummies in the Irish tax functions is different than might be expected. Throughout the period Irish taxes on expenditure rates increased. In particular there was a sharp increase at the end of 1963 (turnover tax) and 1965 (import levy followed by wholesale tax). The resulting relationship between TE and consumption during the period was nonlinear (increasing at an increasing rate). Such a nonlinear relationship could be estimated by transforming the data into logarithms. An alternative is to use zero-one (dummy) variables to form a series of linear approximations. Use of logarithms or dummy variables for a shifting slope would make the model nonlinear -- a complication ruled out a priori by this researcher. Thus, the best that could be done was to approximate the relationship by a series of parallel linear functions -- using dummy variables to shift the intercept only. This led to the curious result of a downward shift in the intercept in 1963 -- the tax rate increase was approximated by an increase in tax exemptions: the tax rise was approximated by a tax cut. Nevertheless, to judge by the low standard error of estimates the approximation appears tolerable.

Personal income is approximated by GNP-TE in the model. The increase in TE reduced the estimate of personal income in 1963. This was not matched by an equivalent reduction in actual personal income so that income tax receipts appeared to rise relative to (GNP-TE) -- there appeared to be an increase in income tax rates. This was once again approximated

Table 4.2. Tax, depreciation and Irish service import dummies

	Variable	Period with value unity
Irish:	ZTE	1963I - 1965IV
	ZTY	1967III - 1968II
	ZD1	1961I - 1962III
	ZD2	1967I - 1968IV
	ZMS1	1966I - 1966III
	ZMS2	1967II - 1968IV
UK:		
	ZTE1	1963III - 1966II
	ZTE2	1962III - 1963III
	ZTE3	1968III - 1968IV
	ZTY1	1961I - 1961IV
	ZTY2	1963II - 1965II
	ZTY3	1965II - 1966II
	ZTY4	1967I - 1967IV
	ZD1	1962I - 1962IV
	ZD2	1965I - 1966IV
	ZD3	1968II - 1968IV

by a downward shift in the intercept. The second dummy in the ITY function served to keep the lower parallel line for a longer time than in the TE function.

Ignoring the shifting intercepts, and the problems caused by the changes in tax rates, the two right hand side variables in the tax functions may be collapsed into a single variable with a fractional lag (Nerlove 1964, p. 122).

Taxes on expenditure functions:

Irish $\quad TE = 0.4755C_{-0.4658}$

UK $\quad TE = 0.4506C_{-0.5925}$

Taxes on income functions:

Irish $\quad TY = 0.2746PY_{-0.4763}$

UK $\quad TY = 0.3090PY_{-0.6987}$

The results indicate that tax receipts lag behind payments in both countries for both taxes but that the lag is longer for the UK. Assuming a 91 day quarter the tax on expenditure lag is 42 days for Ireland and 54 days for UK, and the income tax lag is 54 days for Ireland and 64 days for the UK. The coefficients in the tax functions might indicate that the Irish Government relies more on taxes on expenditure and less on income taxes than the UK Government. The relatively less developed private business sector in Ireland leading to low corporate income tax receipts may be one reason for this result.

Evaluating the functions at the means, average elasticities can be computed for the four taxes. The Irish elasticities are higher than the

UK figures for both taxes. Irish taxes on expenditure have an average elasticity of 2.5; the UK figure is 2. Thus an increase in consumption of 1% is accompanied by an increase in taxes on expenditure receipts of at least 2%. This would suggest that as consumption rises, the allocation changes in favor of more highly taxed commodities. The average elasticity of income tax receipts is 3 for Ireland and 2.2 for the UK. Both countries appear to have progressive income taxes.

The two depreciation functions on the whole appear acceptable. The low Durbin-Watson of the Irish function occurs because there was a significant change in the slope of the relationship at the end of 1963. The intercept dummies do not perform adequately in providing for the slope change. There is therefore a tendency for the function to overestimate in the first couple of years of the sample period. This overestimation can be tolerated because of the extremely low standard error of estimate. Both functions have high $\bar{R}^2$'s and all coefficients have the expected signs and are significant. It should be recalled, however, that the data on both depreciation and the capital stock are of dubious validity.

The same holds true for the Irish imports of services function. The results are satisfactory but depend critically on the estimated data. The impact propensity to import services out of GNP is remarkably similar in both countries (0.028 and 0.029) but the long run propensity is considerably lower for the UK (0.049) than for Ireland (0.069).

In the second estimation of the model the six imports of goods and the two export functions were reestimated. The two export and two of the import functions now appear acceptable. An increase in the UK imports of consumer goods of £ 100 million is accompanied by an increase of £ 5.6 million of Irish exports in the current quarter and an increase of £ 13.6 million in the long run. The Irish share in UK imports of non-durable producer goods is much less, a fact which is not surprising since this category includes basic materials and fuels. A £ 100 million increase in UK imports is accompanied by an increase of £ 0.45 million in Irish exports in the current quarter and a £ 2.1 million increase in the long run.

Both consumer import functions appear satisfactory, but it was decided to do some further experimentation with the UK function because of the low $\bar{R}^2$, DW, and the relatively high standard error of estimate. A number of alternatives were tried (such as replacing consumption with disposable income) and the best is presented below.

Of the other four import functions only that for UK imports of producer nondurables appears satisfactory. The general approach to re-estimating these functions is to interchange I and GNP as explanatory variables. Again the residuals can be examined for structural changes. The results of this third estimation of the import functions are presented below.

<u>Consumer imports function:</u>

UK $$MC = \underset{(20.8)}{0.1108C} + \underset{(6.2)}{83.82ZUMC1} - \underset{(11.2)}{99.58ZUMC2} - \underset{(7.2)}{100.89ZUMC3} - \underset{(111.5)}{3.52}$$

0.9613	1.32
1938.6	18.8

Imports of producer durables functions:

$$\begin{array}{llllllll} \text{Irish} & MPD = & 0.6828MPD_{-1} & + \; 0.0326GNP & - \; 11.82 & & 0.8543 & 1.83 \\ & & (4.70) & (2.16) & (7.86) & & 49.73 & 3.30 \end{array}$$

$$\begin{array}{llllll} \text{UK} & MPD = & 0.2966MPD_{-1} & + \; 0.0747GNP & - \; 116.1ZUMPD1 & - \; 52.88ZUMPD2 \\ & & (2.93) & (8.17) & (7.89) & (4.57) \end{array}$$

$$\begin{array}{lll} - \; 1857 & 0.9939 & 1.12 \\ & 601.8 & 15.4 \end{array}$$

Imports of producer non-durables function:

$$\begin{array}{llllllll} \text{Irish} & MPN = & 0.6086MPN_{-1} & + \; 0.1970I & + \; 14.86Z1MPN & + \; 32.32 & 0.9337 & 1.54 \\ & & (4.36) & (3.53) & (2.26) & (12.47) & 170.61 & 5.85 \end{array}$$

Significant dummy variables appear in three of the equations. They are defined in Table 4.3. The special import levy shifted UK imports of

Table 4.3. Dummy variables for UMC, UMPD, and IMPN functions

Variable	Period with value unity
ZUMC1	1961I - 1962III
ZUMC2	1965I - 1966IV
ZUMC3	1968I - 1968IV
ZUMPD1	1963II - 1967II
ZUMPD2	1967III - 1968II
ZIMPN	1968I - 1968IV

consumer goods downward (1965I - 1966IV) and devaluation (1968I-IV) affected this equation and Irish imports of producer nondurables.

Long run income elasticities for Irish imports are presented in Table 4.4. For the purposes of comparison midpoints of the interval estimates obtained by McAleese (1970) are also given.

Table 4.4. Irish long run import elasticities[a]

	Stronge	McAleese[a]
Consumer goods	2.8	2.1
Producer nondurables	1.9	1.9
Producer durables	1.8	2.3

[a]Source: McAleese (1970, p. 32).

The estimated elasticities are not strictly comparable, because of different data and different economic specification of the equations. The data differed for two reasons: different price, import and income series and different sample periods.

McAleese used unit value indices as deflators and did not preadjust his series for seasonality. He had no GNP or consumption series and interpolated the annual disposable income series in a different manner than this researcher. He did not subtract out unmilled cereals and agricultural materials from producer nondurables, or ships and aircraft from producer durables.

The earlier sample period (1958-66) used by McAleese would tend to give lower elasticities. If we ignore his price terms and all dummies, both import functions have the form

$$M = a_o + a_1 M_{-1} + a_2 Y \qquad a_o < 0 \quad 0 < a_1, a_2 < 1$$

where M is imports and Y is income. In long run equilibrium this becomes

$$M = a_o + b_1 Y \qquad a_o < 0 \qquad 0 < b_1 < 1$$

For a linear function of this form, the income elasticity decreases as GNP decreases, because

$$\text{elasticity} = \text{slope} \cdot \text{average}$$

and with constant slope b_1, the estimated coefficients imply a rising average and therefore, a falling elasticity. Both McAleese and this study evaluated the elasticity at the mean of the sample values. The later sample period used in this study implied a higher average and therefore a lower elasticity.

In the light of this analysis the higher income elasticity found in this study for imports of consumer goods can only be explained by a left-ward movement of that function so that a higher slope resulted. Leser (1967a) reported an elasticity of 0.78 for food, drink and tobacco imports with respect to volume of industrial output. Assuming that as rise in industrial output of 1.7 percent is equivalent to a rise in disposable income of one percent, Leser's results imply an income elasticity of 1.326. Food, drink and toabcco imports can be expected to have a lower income elasticity than consumer goods as a whole. Yet it seems likely that McAleese's estimate is higher than an equivalent estimate obtained from Leser's study. Leser's sample period is 1953-64, McAleese's is 1958-66 and the sample period in this study is 1961-68. Thus the rising income elasticities may be explained by shifting slopes in the consumer import functions. Over the past 20 years Irish consumers changed their pattern of preferences in favor of imported consumer goods. This result might be explained by changing prices if the correct price data were available.

There only remains the interpretation of the consumption and investment functions. Both consumption functions have high $\bar{R}^2$'s, acceptable DW's and low standard errors. The coefficients are all significant and have the expected signs. Although the sum of the coefficients is about 0.98 in both functions, the distribution of this sum differs significantly. This result is very typical of estimates of this type of consumption function, as can be seen from Table 4.5.

Table 4.5. Different estimates of $C = \alpha_1 C_{-1} + \alpha_2 Y$ [a]

Coefficient of Country	Y	C_{-1}	Sum of coefficients
Ireland	0.328	0.647	0.975
UK(1)	0.141	0.850	0.991
US	0.222	0.738	0.961
UK(2)	0.57	0.41	0.980
Belgium	0.819	0.205	1.024
France	0.526	0.447	0.973
Germany	0.520	0.422	0.942
Italy	0.431	0.510	0.941
Netherlands	0.371	0.633	1.004
USA(1)	0.559	0.445	1.004
(2)	0.560	0.444	1.004
(3)	0.634	0.364	0.998
(4)	0.352	0.663	1.015
(5)	0.660	0.280	0.940

[a]Source: US estimates and UK(2) from Evans (1969, ch. 3); Common Market estimates from Resnick (1968, p. 207).

In interpreting Table 4.5 it should be pointed out that only the first three estimates are derived from quarterly data. The US consumption data excludes durable goods and the Common Market countries income is gross national product. Nevertheless the sum of the coefficients is usually just less than unity. The quarterly impact propensities to consume are always less than the annual estimates so that the quarterly coefficients of lagged consumption are larger than the annual estimates. The UK quarterly marginal propensity to consume found in this study is unusually low. The US figure is less than the Irish figure but U.S. consumption excludes durables. The UK (GNP - TE - TY) series consistently underestimates UK personal disposable income and this may partly account for the low impact propensity to consume. If, on average, the series used is 10% less than the actual series, this would raise the coefficient to about 0.I6. There is reason to believe, however, that it is the smoothness of the UK consumption series which biases the coefficient of lagged consumption upwards and therefore, biases the coefficient of income downwards. Inspection of the residuals indicates four occasions when the residuals were significantly larger than the standard error estimate: 1963II, 1966III, 1967III, 1968III. (Standard error = 247.5) (See Table 4.6).

In the second quarter of 1963, Mr. Maudling introduced an expansionary budget which so significantly reduced taxes that dummy variables had to be incorporated in the tax functions to capture the structural change. The tax reduction increased disposable income and therefore consumption. If, as appears likely, the short run marginal propensity to consume is

Table 4.6. Residuals for UK consumption function, £ million

Year	1961	1962	1963	1964	1965	1966	1967	1968
I		12.5	11.9	25.3	-90.9	153.4	58.7	577.2
II	-188.5	132.4	343.9	-179.7	-240.7	57.8	237.5	-725.3
III	-82.3	-115.7	119.3	-111.3	87.2	-385.7	285.8	237.5
IV	-171.9	105.2	-201.8	-18.6	-62.2	-250.4	233.1	126.3

underestimated, this would explain the large positive residuals in 1963II and 1963III.

In the latter half of 1966 the Labor Government introduced the Selective Employment Tax which so drastically increased taxes that a dummy had to be incorporated in the tax functions. The tax increase lowered disposable income and therefore consumption. The underestimate of the short run marginal propensity to consume would again explain the residuals which in this case are negative. The income tax function shifted downwards in 1967 which as in 1963, might explain the positive residuals in that year. In 1968 a severely deflationary budget was introduced after devaluation. This might explain the negative residual for 1968II. The researcher experimented without success with alternative formulations of the lagged term to eliminate the upward bias in its coefficient. Two, three and four quarter lagged moving averages were tried but the estimates of the coefficients did not change significantly.

Both investment functions have high $\bar{R}^2$'s, acceptable Durbin-Watsons and low standard errors of estimates. All coefficients have the expected signs and all are significant except that for the Irish capital stock. Both functions show evidence of serious pairwise multicollinearity between GNP and K according to Klein's rule of thumb. The partial correlation coefficient for GNP and K is the same in both countries (0.98) and is larger than the multiple correlation coefficients (0.95 for Ireland, 0.97 for the UK). Klein's rule of thumb indicates a multicollinearity problem and this may explain the high standard error (low t) obtained for K.

The relationship of the coefficients for I_{-1} and GNP is the opposite for the two countries: the former being larger for Ireland and smaller for the UK. The high Irish value may be due to the smoothness of the Irish series on stocks and investment in "other building and construction" which were obtained by smooth interpolation of the annual figures. On the other hand, the small Irish business sector may mean that a large component of Irish investment is independent of the level of output and depends more on Government policy which is made on an annual basis.

CHAPTER V. TEST OF THE PREDICTIVE PERFORMANCE OF THE MODEL DURING THE SAMPLE PERIOD

The Reduced Form of the System

The complete model in its final estimated form contains 30 endogenous variables which are determined by 20 equations and 10 identities. In this chapter, the predictive performance of the model during the sample period is tested. Before doing this, 8 identities can conveniently be eliminated:

$$NI = I - D \qquad \text{I.2}$$

$$K = K_{-1} + NI \qquad \text{I.3}$$

$$PY = GNP - TE \qquad \text{I.4}$$

$$DY = GNP - TE - TY \qquad \text{I.5}$$

The above four identities appear in the submodels of each country. I.2 is a definition of net investment (NI), a variable which appears only once elsewhere in the model namely I.3. This latter identity, which defines the current value of the capital stock, can itself be eliminated. The capital stock enters the investment and depreciation equations of the model but always lagged one quarter. Thus, it is a predetermined variable during the sample period. If the model was to be used as an ex ante forecasting device, to predict the endogenous variables for more than one quarter after the end of the sample period, then the capital stock identity would have to be retained. If the dynamic structure of the model was to be used for simulation purposes, the identity would also have to be retained. But for the purpose of testing the predictive ability of the model during the sample period, the identity can be eliminated. I.2 is therefore also eliminated.

The other two identities (I.4 and I.5) can also be eliminated if their right hand sides are substituted into the rest of the model. Personal income (PY) appears in the income tax function:

$$TY = \lambda_o + \lambda_1 PY + \lambda_2 PY_{-1}$$

This can be rewritten

$$TY = \lambda_o + \lambda_1 GNP - \lambda_1 TE + \lambda_2 GNP_{-1} - \lambda_2 TE_{-1} \quad .$$

It is noteworthy that the elimination of PY, an endogenous variable, increases the number of predetermined variables because PY_{-1} is replaced by GNP_{-1} and TE_{-1}.

Disposable income (DY) appears in the consumption function:

$$C = \alpha_1 C_{-1} + \alpha_2 DY$$

which can be rewritten

$$C = \alpha_1 C_{-1} + \alpha_2 GNP - \alpha_2 TE - \alpha_2 TY \quad .$$

The elimination of the 8 identities reduces the number of structural relations to 22. Writing all the endogenous variables on the left hand side the model now becomes:

$$IGNP - IC - II + IMC + IMPD + IMS - IXC - IXPN = IA$$

$$UGNP - UC - UI + UMC + UMPN + UMS = UB$$

$$IC - 0.3277IGNP + 0.3277ITE + 0.3277ITY = 0.6470IC_{-1}$$

$$UC - 0.1405UGNP + 0.1405UTE + 0.1405UTY = 0.8495UC_{-1}$$

$II - 0.2496IGNP = -159.5 + 0.8075II_{-1} - 0.0130IK_{-1}$

$UI - 0.5385UGNP = -11,846 + 0.3022UI_{-1} - 0.0177UK_{-1}$

$IMC - 0.1970IC = -80.9 + 0.4415IMC_{-1}$

$UMC - 0.1108UC = -352 + 83.82ZUMC1 - 99.58ZUMC2 - 100.89ZUMC3$

$IMPD - 0.0326\ IGNP = -11.82 + 0.6826IMPD_{-1}$

$UMPD - 0.0747UGNP = -1857 + 0.2966UMPD_{-1} - 116.1ZUMPD1 - 52.88ZUMPD2$

$IMPN - 0.1968II = 32.32 + 0.6086IMPN_{-1} + 14.86ZIMPN$

$UMPN - 0.0972\ UGNP = -1660 + 0.5059UMPN_{-1}$

$IMS - 0.0283IGNP = -13.55 + 0.5875IMS_{-1} + 1.648ZIMS1 - 1.175ZIMS2$

$UMS - 0.0287UGNP = 72 + 0.4151UMS_{-1}$

$ITE - 0.2540IC = -174.55 + 0.2215IC_{-1} - 8.6995ZITE$

$UTE - 0.1836UC = -4636.4 + 0.2670UC_{-1} - 333.1ZUTE1 - 134.2ZUTE2 +502.8ZUTE3$

$ITY - 0.1438IGNP + 0.1438ITE = -134.+ 0.1308IGNP_{-1}- 0.1308ITE_{-1} - 6.263ZIT$
$- 6.566ZITY$

$UTY - 0.0931UGNP + 0.0931UTE = -4134.4 + 0.2159UGNP_{-1}- 0.2159UTE_{-1}$
$- 219.7ZUTY1 - 729.3ZUTY2 - 549.7ZUTY3 - 142.8ZUTY4$

$ID = 52.2 + 0.0080IK_{-1} + 3.96ZID1 - 1.43ZID2$

$UD = 2099.4 + 0.0085UK_{-1} - 14.66ZUD1 - 27.89ZUD2 - 28.63ZUD3$

$IXC - 0.0558UMC = -80.43 + 0.5910IXC_{-1}$

$IXPN - 0.0050UMPN = -5.53 + 0.7856IXPN_{-1}$.

This system of equations can be written in matrix form

$$AY_t = BX_t \qquad t = 1961III \text{ to } 1968IV$$

where Y_t is a 22x 1 vector of values of the 22 endogenous variables at time t, X_t is a 41 x 1 vector of values of the 41 predetermined variables at time t, A and B are coefficient matrices. The substantial increase in the number of predetermined variables occurred as a result of the inclusion of 19 dummy variables, the elimination of the identities, and the addition of a column of ones for the intercept terms. The A matrix is 22 x 22 and the B matrix is 22 x 41. Inverting the A matrix provides the reduced form of the system

$$Y_t = A^{-1}BX_t \qquad t = 1961\text{II to } 1968\text{IV} .$$

Substitution of the observed 31 vectors (41 x 1) of observations on X_t provides 31 estimated vectors of observations on Y_t.

Tests of the Predicted Values During the Sample Period

The predicted and actual values, their differences and percentage differences for all the endogenous variables are presented in Appendix B, Tables B1 through B22. Along with each table, the graph of the predicted and actual values during the sample period (1961II-1968IV) is presented.

Examination of the graphs against time shows that the two series are, to some extent, out of phase. That is, the predicted series has the same movements as the actuals but there is often a one-quarter lag. This may be explained by the effect of random shocks on the actual series. Thus, when a strike occurs, if the original series has not been successfully adjusted, the actual value jumps down in the strike quarter and then back up the following quarter. The predicted series fails to jump down during the strike. In the quarter after the strike the downward jump in the lagged dependent variable causes the predicted series to drop and two quarters after the strike the predicted series jumps back up.

Figure B.7 depicts the relationship between the actual predicted values of Irish consumer exports to the UK, plotted against time. Consider 1966 II. In this quarter there was a seamen's strike. The actuals dropped while the predicted series increased. Then in 1966 III, the actual series recovered strongly while the predicted series dropped. In 1966 IV, the actuals dropped slightly because the high rate of 1966 III which signified a recovery from the strike could not be maintained. The predicted values increased substantially under the influence of the lagged dependent term.

There are many different methods of testing the accuracy of the predicted values during the sample period. A common approach is to compare the predictive ability of the model with that of various naive models. Such models assume that this quarter's prediction is some function of previous actual values, or that this quarter's predicted change is some function of previous changes. While such approaches merit consideration this researcher chose the approach followed below for three reasons. First, it is difficult to justify choosing one naive model over another--one naive model may be much more reasonable for one variable than for another. Second, naive models usually ignore the interrelationships in the system by focusing on one variable alone (such as GNP). For a true test, a multiple equation naive model is needed but such an enterprise would be very demanding on the resources of the researcher. Third, the regression procedure outlined below provides more than one test of the model's predictive accuracy.

The variables in the regressions are A and P, where A stands for actual and P for predicted values. On the left of each equation the symbol for th endogenous variable is given. The actual values were regressed against the predicted values because it is the acutal values that one is trying to "explain". The usual four statistics are presented to the right of each equation:

$\bar{R}^2$, D.W., mean of dependent variable, SEE. The two extra statistics on the far right of each equation are the standard deviations. The upper value is the standard deviation of the predicted series; the lower is the standard deviation of the actual series. These equations and the statistics will be used to test the predictive ability of the model during the sample period.

IGNP	A = 0.9944P + 6.21	0.9714	2.17	79.4
	(0.0312) (27.13)	868.7	13.54	80.0
IC	A = 0.9991P + 1.86	0.9510	2.16	41
	(0.0414) (25.8)	624.5	9.3	42
II	A = 0.9810P + 3.72	0.8601	1.93	29.6
	(0.0721) (12.7)	174.4	11.7	31.3
IMC	A = 0.9874P + 1.14	0.8633	2.09	13.8
	(0.0715) (5.36)	73.9	5.4	14.6
IMPD	A = 0.9927P + 0.4396	0.8453	1.81	8.0
	(0.0773) (3.89)	49.7	3.4	8.7
IMPN	A = 1.0179P - 2.99	0.9338	1.76	21.6
	(0.0494) (8.50)	170.6	5.84	22.7
IMS	A = 0.9981P + 0.11	0.9832	1.30	5.0
	(0.0238) (0.62)	25.7	0.66	5.1
IXC	A = 1.0293P - 1.87	0.8750	2.06	11.7
	(0.0709) (4.78)	66.6	4.54	12.8
IXPN	A = 1.0019P - 0.073	0.9456	1.64	6.6
	(0.04384) (1.374)	30.7	1.57	6.7
ITE	A = 1.0295P - 6.63	0.9210	1.23	19.5
	(0.0550) (6.73)	117.9	5.87	20.9
ITY	A = 0.9981P + 0.38	0.9761	2.64	15.4
	(0.0251) (1.98)	68.2	2.40	15.5
ID	A = 1.2390P - 17.2	0.8914	0.17	6.67
	(0.0788) (5.17)	63.7	2.88	8.73
UGNP	A = 0.9741P + 845.5	0.9459	1.84	2087
	(0.0425) (1342.7)	31.558	486	2088

UC	A = 1.0082P - 173.83	0.9535	2.04	1203
	(0.0406) (849.61)	20.871	267.8	1241
UI	A = 0.9525P + 295.6	0.8155	1.90	792
	(0.0824) (500.5)	6034	357.3	832
UMC	A = 1.0388P - 74.88	0.8611	1.64	85.6
	(0.0760) (147.4)	1939	35.6	95.6
UMPD	A = 0.9305P - 40.25	0.9517	1.26	206.8
	(0.0382) (24.4)	602	43.3	197.1
UMPN	A = 1.0170P - 48.8	0.9639	1.89	392.9
	(0.0359) (102.1)	2815	77.3	406.7
UMS	A = 1.0047P - 7.01	0.9084	1.66	101.2
	(0.0581) (97.0)	1665	32.2	106.5
UTE	A = 1.0104P - 50.09	0.9823	1.70	638
	(0.0248) (115.6)	4622	86.6	650
UTY	A = 1.0197P - 75.9	0.9853	1.82	487.4
	(0.0228) (87.7)	3823	60.8	500.5
UD	A = 0.9980P + 2.9578	0.9992	1.46	268
	(0.0053) (13.374)	2525	7.72	267

The above regressions can be used to judge the predictive ability of the model during the sample period. However, in interpreting the results it should be borne in mind that

> with today's modern technology, good sample period fits and good ex post forecasts are limited only by the amount of available computer time, the number of research assistants and one's own patience (Evans 1969, p. 516).

The first test that can be performed using the results of the above regressions is to test the hypotheses of zero intercept and slope unity. A convenient test is to subtract the point estimate of the intercept from zero and compare it to its standard error; similarly subtract the point estimate of the slope from unity and compare the result with the standard error. Only two series fail to meet the standards of this test - Irish depreciation and UK imports of producers durables. The poor performance of Irish depreciation is not surprising and reflects the poor fit in 1961-62. (See Figure B.12.) The relationship between Irish depreciation and the capital stock is nonlinear -- the slope shifts at the end of 1962. Thus, approximation with parallel lines fails to give a close fit. Nevertheless, the error can be tolerated because it is only at the beginning of the sample period and the magnitude is small (about £ 8 million) when compared to GNP (£ 770 million). In addition, the depreciation function plays a small role in the model. It depends only on the lagged value of the capital stock and in applications would only be used to estimate net investment (and thereby the capital stock). The capital stock term, aside from the depreciation function, only enters the investment function and has a coefficient of less than one percent.

The failure of the UK producers' durables import function also reflects a poor fit in 1961. The first two quarters of 1963 are also poorly predicted. These errors partly reflect the unevenness of the original series which may be due to the indivisibility of imported capital equipment. (The Irish function was estimated after ships and aircraft were subtracted). Nevertheless the results also indicate misspecification and the reestimation of this function should be a top priority for further research. The existing errors can probably be tolerated because the magnitude of the series is so small. During the sample period average UK GNP was £ 31.6 billion; average UK imports of producers' durables was £ 602 million.

A second test of the predictive ability of the model during the sample is provided by the Durbin-Watson statistic. Negative serial correlation probably exists for those equations with Durbin Watsons less than 1.35; probably is not present in those equations with values above 1.49, and is uncertain for values intermediate between the two. If serial correlation exists, this would indicate a tendency for the model to underestimate during a series of years and then to overestimate during the remaining years. This could reflect structural change which was poorly approximated by linear relationships.

The two functions that failed the previous test also fail the Durbin-Watson test. In addition two other Irish equations appear to have negative serial correlation (imports of services and taxes on expenditure) and one other UK equation has a Durbin Watson that falls in the top of the uncertain range (depreciation).

The Irish service imports and UK depreciation series were derived by smoothly interpolating the annual figures using the Sandee-Lisman technique. As mentioned in the last chapter this technique fits a nonlinear trend (weighted moving average) to the annual data. The corresponding explanatory variables in the structural equations for the variables under discussion are Irish GNP and the UK capital stock. These tend to follow a linear trend. Thus, the functions are nonlinear and the low Durbin-Watsons indicate that the linear approximations are relatively inaccurate.

The Irish taxes on expenditure function is nonlinear with the slope increasing over the sample period as the Government raised the tax rate.

Again the linear approximation appears to be relatively inaccurate. Some idea of the seriousness of the error introduced by each equation can be seen by comparing the standard error and estimates. Of course, in a simultaneous system an error of prediction for one variable will most likely lead to errors in all variables. Thus, for example, GNP is obtained from an identity so that all error in GNP reflects errors in its components.

The result of ranking the equations of the model by size of standard error of estimate are presented in Table 5.1. The Irish variables have smaller standard errors of estimate than their UK counterparts, and the larger variables have, in general, smaller errors than the smaller ones. This suggests that the ranking by standard error reflects more the size than the accuracy of the variables. The variables ranked by the size of their mean are also presented in the table. There is close correspondence between the two ranking schemes. Indeed, where they differ may provide a test of the accuracy of the equations. For example, if the ranking is reversed so that a variable with a higher standard error has a lower mean than another variable, the equation gives a relatively poor fit. Six equations are relatively inaccurate by this criterion: IMPD, ITE, IT, UMPD, UMPN, UI. Two new import functions enter the "poor" category: IMPD and UMPN. The poor rating of the investment functions is due to their relative inaccuracy compared to the consumption functions, a well known result.

Dividing the standard errors of estimate by the mean yields a coefficient of variation which provides a criterion for ranking the variables

Table 5.1. Ranking of the equations by various criteria

Rank by size of	Standard error of estimate	Mean	Coefficient of variation
1	IMS	IMS	UD
2	IXPN	IXPN	UC
3	ITY	IMPD	IC
4	ID	ID	UGNP
5	IMPD	IXC	IGNP
6	IXC	ITY	UTY
7	IMC	IMC	UMC
8	IMPN	ITE	UTE
9	ITE	IMPN	UMS
10	IC	II	IMS
11	II	IC	UMPN
12	IGNP	IGNP	IMPN
13	UD	UMPD	ITY
14	UMS	UMS	ID
15	UMC	UMC	ITE
16	UMPD	UD	IXPN
17	UTY	UMPN	UI
18	UMPN	UTY	II
19	UTE	UTE	IXC
20	UC	UI	IMPD
21	UI	UC	UMPD
22	UGNP	UGNP	IMC

according to their relative accuracy. The high ranking of the GNP series is encouraging and indicates that errors in the components cancel each other to some extent. On the whole, the British variables perform better than their Irish counterparts. However, the relatively poor fit of the Irish export functions may reflect the poor performance of UK imports relative to other UK variables.

Finally, it is instructive to compare the standard deviation of the actual values with the standard deviation of the predicted values. Ideally, these two should be the same. If the standard deviation of the actual values is larger than that of the predicted values, this would reflect the fact that the predicted series is smoother. The latter smoothness is to be expected. If the standard deviation of the actual values is lower, this indicates poor performance on the part of the predicted series. One variable fails this test, UMPD, and this confirms the need for more work on the UK producers' durables import function.

In conclusion, the twenty-two endogenous variables are predicted by the Anglo-Irish model with an acceptable degree of accuracy. The main target variable, Irish GNP, passes all tests. The UK variables contribute larger errors than their Irish counterparts. This reflects their larger size, however, because they are relatively more accurate. Some structural relationships appear to be nonlinear and approximation of these by parallel lines is relatively unsatisfactory. This is especially true of Irish taxes on expenditure and those series which were originally estimated using the Sandee-Lisman technique. One variable consistently performs poorly, UK imports of producers' durables. This may reflect the unevenness of the original series due to the indivisibility of capital goods. The minor role played by UKMPD in the model, where it only enters the GNP identity and where its size is very small, makes the error in this series tolerable.

CHAPTER VI. THE USE OF THE MODEL FOR POLICY MAKING

The last chapter presented tests of the predictive accuracy of the model during the sample period, that is, of how closely the model fits the data on which it is based. The satisfactory results obtained, however, do not guarantee predictive accuracy outside the sample period; a close fit during the sample period is quite consistent with disappointing forecasts afterwards. Such predictions, known as ex ante forecasts require additional information which must usually be assumed. In particular, either the same structure must be assumed to hold (as represented by the values of the coefficients in the structural equations) or some alternative assumption must be made. In addition, the values of the exogenous variables since the close of the sample period must often be projected.

Nevertheless an analysis of the ex ante forecasting ability of a model provides a powerful test of its accuracy. Indeed it can be argued that the ultimate objective of macroeconometrics is the generation of reliable ex ante forecasts of macroeconomic magnitudes. Thus models can be evaluated according to their ex ante forecasting ability. Unfortunately, insufficient observations on the Irish data are available since the end of the sample period to permit such an evaluation at this time.

However, it can be argued that use of the model to analyze problem situations is still a useful exercise in spite of the uncertainty regarding its ex ante forecasting ability. In the absence of alternative estimates, the results of the model are clearly useful. More likely, however, the results of the model will provide a useful starting point for discussion. Thus the model may broaden the horizon of the policy maker by presenting quantitative estimates of the impact of his decisions on other sectors of the economy, or it may lengthen his horizon by quantifying the time lags between his decisions and their effects. It may not be necessary to secure acceptance of the model's estimates; the contribution of the model might be the acceptance of some nonzero values for these linkages. Moreover the qualitative results of the model might continue to hold outside the sample period. Such results are the signs of the various multipliers generated by the model or the time pattern of the impact of policy changes on target variables. Finally the model may demonstrate the sensitivity of the results to the actual values assumed.

The results would also have implications for the researcher. They would draw attention to the model's weaknesses and thereby establish priorities for further research. Different economic specifications of individual equations could be inserted into the model and compared. More fruitful disaggregations might be suggested and the sensitivity of the results to the statistical techniques employed could be quantified. Thus, this researcher views a macroeconometric model as an ongoing process rather than a fixed set of equations. Models, like living things, must continually adapt to a changing environment or become extinct.

In this chapter a start is made on providing the tools to analyze problem situations which may confront the policy maker. Given the limited time and resources remaining to the researcher, the uses of the model can only be illustrated. The first half of the chapter presents multipliers generated by the model; the second half illustrates a simulation procedure. Given the tentative nature of this first attempt to estimate a quarterly macroeconometric model, the results of this chapter should be interpreted with caution.

Modification of the Model for Policy Making

Since the balance of payments constraint is so important to Anglo-Irish policy makers, it is desirable to add an indicator of the balance of payments to the model. This is done by defining

$$IBT = IA + IXC + IXPN - IMC - IMPD - IMPN - IMS$$

$$UBT = UB - UMC - UMPD - UMPN - UMS$$

where IBT is an indicator of the Irish balance of trade and UBT is an indicator of the UK balance of trade. These are indicators because they include, for example, government purchases. In the applications that follow government purchases are therefore treated like exports. This is done for computational convenience and could be changed without altering the results below, because it is with exports rather than government purchases that this chapter is concerned. To avoid confusion, the variables IA and UB will hereafter be referred to as "autonomous exports".

The identities for net investment and the capital stock are also restored in this chapter. To avoid excessive complexity, however, the 19 dummy variables in the model were eliminated. This was done by solving for the intercepts that prevailed in 1964-65. There was some difficulty where dummies entered midway through the period, in which case some average intercept was chosen.

The use of the 1964-65 intercepts means that any extrapolation of the results of this chapter assumes that the economic structure that prevailed then continues to hold true. While it is unlikely that this is so, it might be argued that later structural changes will leave the qualitative results unchanged. The direction of changes and the distribution of their impact over time might have remained relatively constant. The 1964-65 period was chosen because it contains the sample averages and regression lines pass through these points.

Including the above two identities the resulting model is as follows:

II1 $IGNP - IC - II + IMC + IMPD + IMPN + IMS - IXC - IXPN = IA$

IE1 $-0.3277IGNP + IC + 0.3277ITE + 0.3277ITY = 0.6460IC_{-1}$

IE2 $-0.2496IGNP + II = 0.8075II_{-1} - 0.01301K_{-1} - 159.5$

IE3 $-0.1970IC + IMC = 0.4415IMC_{-1} - 80.93$

IE4 $-0.0326IGNP + IMPD = 0.6826IMPD_{-1} - 11.82$

IE5 $-0.1970II + IMPN = 0.6086IMPN_{-1} + 32.32$

IE6 $-0.0283IGNP + IMS = 0.5875IMS_{-1} - 13.6$

IE7 $-IXC - 0.0558UMC = 0.5910IXC_{-1} - 80.43$

IE8 $-IXPN - 0.0045UMPN = 0.7856IXPN_{-1} - 5.53$

IE9 $-0.2540IC + ITE = 0.2215IC_{-1} - 183.3$

IE10 $-0.1438IGNP + 0.1438ITE + ITY = 0.1308IGNP_{-1} - 0.1308ITE_{-1} - 140.3$

IE11 $-ID = 0.0080IK_{-1} + 52.2$

II2 $-II + ID + INI = 0$

II3 $- INI + IK = IL_{-1}$

II4 $IMC + IMPD + IMPN + IMS - IXC - IXPN + IBT = IA$

UI1 $UGNP - UC - UI + UMC + UMPD + IMPN + UMS = UB$

UE1 $- 0.1405UGNP + UC + 0.1405UTE + 0.1405UTY = 0.8495UC_{-1}$

UE2 $- 0.5385UGNP + UI = 0.3022UI_{-1} - 0.0177UK_{-1} - 11{,}846.0$

UE3 $- 0.1108UC + UMC = - 400$

UE4 $- 0.0747UGNP + UMPD = 0.2966UMPD_{-1} - 1973$

UE5 $- 0.0972UGNP + UMPN = 0.5059UMPN_{-1} - 1660$

UE6 $- 0.0287UGNP + UMS = 0.4151UMS_{-1} + 72$

UE7 $- 0.1836UC + UTE = 0.2670UC_{-1} - 4969$

UE8 $- 0.0931UGNP + 0.0931UTE + UTY = 0.2159UGNP_{-1} - 0.2159UTE_{-1} - 4884$

UE9 $UD = 0.0085UK_{-1} + 2070$

UI2 $- UI + UD + UNI = 0$

UI3 $- UNI + UK = UK_{-1}$

UI4 $UMC + IMPD + UMPN + UMS + UBT = UB$

This system of equations can be written in matrix form as

$$AY_t = BY_{t-1} + CX_t$$

where Y_t is a 28-dimensional column vector of endogenous variables, Y_{t-1} is the same vector lagged one quarter and X_t is a 3-dimensional column vector of exogenous variables. The three exogenous variables are the intercept, Irish autonomous exports (IA) and UK autonomous exports (UB). The matrices A, B, C are 28 x 28, 28 x 28, and 28 x 3 respectively.

Multiplier Analysis of the Model

The reduced form for this system can be written as follows:

$$Y_t = A^{-1}BY_{t-1} + A^{-1}CX_t = \Pi_1 Y_{t-1} + \Pi_2 X_t$$

In period t = 1 this becomes

$$Y_1 = \Pi_1 Y_0 + \Pi_2 X_1$$

and in period t = 2

$$Y_2 = \Pi_1 Y_1 + \Pi_2 X_2$$

but this can be written

$$Y_2 = \Pi_1 [\Pi_1 Y_0 + \Pi_2 X_1] + \Pi_2 X_2$$

$$= \Pi_1^2 Y_0 + \Pi_1 \Pi_2 X_1 + \Pi_2 X_2$$

so that in period t = n

$$Y_n = \Pi_1^n Y_0 + \Pi_1^{n-1} \Pi_2 X_1 + {}_1^{n-2}\Pi_2 X_2 + \dots + \Pi_2 X_n \quad .$$

Partially differentiating Y_n with respect to $X_1 \dots X_n$ yields matrices of impact and delayed multipliers. In this study n was chosen equal to 8. Ignoring the multipliers for changes in the intercepts, the matrices are presented in Table 6.1.

The interpretation of Table 6.1 is as follows. Reading down the first column are the multipliers for the effect on the endogenous variables of a change in Irish autonomous exports. For example, an increase of £ 1 million in Irish autonomous exports increases Irish GNP by £ 1.54 million, of which £ 1 million is accounted for by the assumed rise in exports. The remaining £ 0.54 million is the rise in consumption and investment less the rise in imports. The £ 1 million rise in exports less the £ 0.25 million rise in imports causes the trade balance to increase by £ 0.75 million.

Table 6.1. Impact multipliers for the effect changes in autonomous exports on the endogenous variables

	I		II		III		IV		V	
	IA	UB	IA	UB	IA	UB	IA	UB	IA	UB
I GNP	1.5393	0.0034	0.3621	0.0057	0.2914	0.0073	0.2309	0.0082	0.1772	0.0087
C	0.4041	0.0009	0.2584	0.0018	0.2095	0.0027	0.1680	0.0034	0.1327	0.0039
I	0.3842	0.0008	0.3956	0.0021	0.3821	0.0035	0.3512	0.0048	0.3084	0.0059
MC	0.0796	0.0002	0.0861	0.0004	0.0793	0.0007	0.0681	0.0010	0.0562	0.0012
MPD	0.0502	0.0001	0.0461	0.0003	0.0409	0.0004	0.0355	0.0006	0.0300	0.0007
MPN	0.0757	0.0002	0.1240	0.0005	0.1507	0.0010	0.1609	0.0015	0.1587	0.0021
MS	0.0436	0.0001	0.0358	0.0002	0.0293	0.0003	0.0237	0.0004	0.0190	0.0005
XC		0.0014		0.0019		0.0022		0.0022		0.0021
XPN		0.0008		0.0012		0.0014		0.0014		0.0013
TE	0.0990	0.0002	0.1528	0.0006	0.1086	0.0011	0.0876	0.0014	0.0697	0.0017
TY	0.2071	0.0005	0.2185	0.0011	0.0537	0.0015	0.0445	0.0018	0.0342	0.0019
D			0.0031	0	0.0062	0	0.0092	0.0001	0.0120	0.0001
NI	0.3842	0.0008	0.3926	0.0021	0.3759	0.0024	0.3420	0.0047	0.2964	0.0058
K	0.3842	0.0008	0.7768	0.0029	1.1526	0.0063	1.4946	0.0111	1.7911	0.0168
IBT	0.7510	0.0016	-0.2920	0.0017	-0.3003	0.0011	-0.2882	0.0001	-0.2639	-0.0011
UGNP		1.8136		0.4356		0.2649		0.1760		0.1249
C		0.2258		0.1816		0.1676		0.1499		0.1320
I		0.9766		0.5124		0.2713		0.1460		0.0783
MC		0.0250		0.0201		0.0186		0.0166		0.0146
MPD		0.1355		0.0727		0.0414		0.0254		0.0169
MPN		0.1763		0.1315		0.0923		0.0638		0.0444
MS		0.0521		0.0341		0.0218		0.0141		0.0094
TE		0.0415		0.0936		0.0793		0.0723		0.0643
TY		0.1650		0.4144		0.0911		0.0497		0.0280
D		0		0.0083		0.0126		0.0148		0.0159
NI		0.9766		0.5041		0.2587		0.1312		0.0624
K		0.9766		1.4807		1.7394		1.8706		1.9330
UBT		0.6112		-0.2585		-0.1740		-0.1199		-0.0853

Table 6.1. (Continued)

	VI		VII		VIII	
	IA	UB	IA	UB	IA	UB
I GNP	0.1279	0.0087	0.0820	0.0084	0.0391	0.0078
C	0.1019	0.0041	0.0743	0.0042	0.0493	0.0041
I	0.2577	0.0067	0.2021	0.0072	0.1441	0.0074
MC	0.0449	0.0013	0.0345	0.0014	0.0249	0.0014
MPD	0.0246	0.0007	0.0195	0.0008	0.0146	0.0008
MPN	0.1473	0.0026	0.1295	0.0030	0.1072	0.0033
MS	0.0148	0.0005	0.0110	0.0006	0.0076	0.0005
XC		0.0020		0.0018		0.0016
XPN		0.0011		0.0010		0.0008
TE	0.0544	0.0019	0.0408	0.0019	0.0285	0.0019
TY	0.0246	0.0019	0.0155	0.0018	0.0069	0.0017
D	0.0143	0.0001	0.0163	0.0002	0.0178	0.0002
NI	0.2434	0.0066	0.1858	0.0070	0.1263	0.0071
K	2.0344	0.0234	2.2202	0.0304	2.3466	0.0375
IBT	-0.2316	-0.0021	-0.1944	-0.0030	-0.1543	-0.0036
UGNP		0.0906		0.0639		0.0411
C		0.1146		0.0983		0.0831
I		0.0382		0.0114		-0.0089
MC		0.0127		0.0109		0.0092
MPD		0.0118		0.0083		0.0055
MPN		0.0313		0.0220		0.0151
MS		0.0065		0.0045		0.0031
TE		0.0563		0.0487		0.0415
TY		0.0163		0.0088		0.0033
D		0.0164		0.0166		0.0166
NI		0.0218		-0.0052		-0.0255
K		1.9548		1.9495		1.9240
UBT		-0.0623		-0.0457		-0.0329

UK variables, and consequently Irish exports to the UK, are assumed to be unaffected by changes in Irish autonomous exports. Irish depreciation depends on the lagged value of the capital stock which is unaffected in the first quarter.

The second column gives the effect of a change in UK exports of £ 1 million. All variables other than depreciation are affected. The third and fourth columns give the effect of changes in first quarter autonomous exports on second quarter endogenous variables. Because second quarter autonomous exports are assumed unchanged, the multipliers for the effect on the trade balances are both negative. The remaining columns trace the effect of changes in first quarter autonomous exports on the values of the endogenous variables through six more quarters.

The results are extremely sensitive to the estimated coefficients of the lagged endogenous variables. Consider the two rows for consumption and the two rows for investment:

Table 6.2. Effect of a £ 1 million increase in autonomous exports on consumption and investment £ million

	I	II	III	IV	V	VI	VII	VIII
IC	0.40	0.26	0.21	0.17	0.13	0.10	0.07	0.05
UC	0.23	0.18	0.17	0.15	0.13	0.12	0.10	0.08
II	0.38	0.40	0.38	0.35	0.31	0.26	0.20	0.14
UI	0.98	0.51	0.27	0.15	0.08	0.04	0.01	-0.01

Recall now the corresponding structural equations

$$IC = 0.6470IC_{-1} + 0.3277IDY$$

$$UC = 0.8495UC_{-1} + 0.1405UDY$$

$$II = 0.8075II_{-1} + 0.2496IGNP - 0.0130IK_{-1} - 159.5$$

$$UI = 0.3022UI_{-1} + 0.5385UGNP - 0.0177UK_{-1} - 11{,}846$$

The sum of the coefficients in the two consumption functions is about the same, but the Irish coefficient of the lagged term is much lower than the UK figure. Correspondingly, the UK impact propensity to consume is smaller than the Irish figure. Thus the initial impact of a change in autonomous exports on Irish consumption is much larger than on UK consumption but the effect on Irish consumption trails away more rapidly. (See rows 1 and 2 of Table 6.2).

The opposite occurs in investment where the Irish coefficient of the lagged term is larger and the Irish coefficient of GNP is smaller than the corresponding UK figures. Thus the initial impact of a change in autonomous exports on Irish investment is smaller than on UK investment, but the effect trails away more slowly.

This sensitivity is compounded by the simultaneity of the system. Thus, one of the reasons why UK gross national product declines less rapidly than Irish gross national product is the slower decline in UK consumption but this slower decline in gross national product itself slows the decline in UK consumption.

It is therefore important to estimate the lag structures for each structural equation as accurately as possible. This researcher specified the Koyck distribution for computational convenience and so it is clear that no more than a start has been made at estimating the lag structures for the Anglo-Irish economy. Alternative lag distributions might be specified or estimated using the Almon technique (Almon 1965). In the long run, lag structures which depend on the level of economic activity may have to be developed. Thus the analysis so far illustrates two of the points made in the introductory to this chapter. The model shows the sensitivity of the results to the estimated values of the structural coefficients and aids in establishing priorities for future research.

In addition to tracing the effect of an autonomous change through time it is natural to ask the following question: What will be the net effect of the initial change after all effects have worked themselves out over time? Or, to rephrase, after infinite time has passed what will be the effect of the initial change? Consider again the reduced form

$$Y_t = \pi_1 Y_{t-1} + \pi_2 X_t$$

which for period t = n was derived to be

$$Y_n = \pi_1^n Y_0 + \pi_1^{n-1} \pi_2 X_1 + \pi_1^{n-2} \pi X_2 + \dots + \pi_2 X_n$$

Assuming no change in X after the initial change from X_0 to X_1 then

$$X_1 = X_2 = X_3 = \dots = X_n$$

so that

$$Y_n = \pi_1^n Y_0 + (\pi_1^{n-1} \pi_2 + \pi_1^{n-2} \pi_2 + \dots + \pi_2)\, X_1$$

$$= {}_1^n Y_0 + (\pi_1^{n-1} + \pi_1^{n-2} + \dots + \pi_1^2 + \pi_1^1 + \pi_1^0)\, \pi_2 X_1 \; .$$

Assuming, as is true for this model, that the elements of Π_1 are less than unity, then as n goes to infinity the equation becomes

$$Y_E = (I - \Pi_1)^{-1} \Pi_2 X_1$$

where I is the identity matrix and Y_E denotes the long run equilibrium value. Thus the elements of the matrix $(I - \Pi_1)^{-1} \Pi_2$ provide long run multipliers of the kind described above. The columns of this matrix for the effect of changes in IB and UB are presented in Table 6.3.

Table 6.3. Long run multipliers for other autonomous demand changes

	IA	UB		IA	UB
GNP	1.2963	0.0212	IBT	0.4540	0.0074
IC	0.6643	0.0109	UGNP		1.4008
II	0.1780	0.0029	UC		0.7001
IMC	0.2343	0.0038	UI		0.2713
IMPD	0.1331	0.0022	UMC		0.0776
IMPN	0.0896	0.0015	UMPD		0.1488
IMS	0.0889	0.0015	UMPN		0.2756
IXC	0	0.0106	UMS		0.0687
IXPN	0	0.0058	UTE		0.3155
ITE	0.3099	0.0051	UTY		0.3354
ITY	0.2709	0.0044	UD		0.2713
ID	0.1780	0.0029	UNI		0
INJ	0	0	UK		31.9208
IK	22.2527	0.3642	UBT		0.4249

Attention might be drawn to three sets of values in the table. First, the long run effect of the export change on net investment is zero. This result can be explained because income is assumed not to grow in long run equilibrium. The assumption could be modified by postulating _a priori_ a certain growth rate for income in long run equilibrium (see Ball and Drake 1964, p. 68 and Evans 1969, p. 25). The mathematics is more complicated and such a procedure is not attempted in this study.

The multiplier for the effect of increases in autonomous exports on gross national product are 1.3 for Ireland and 1.4 for the UK. The UK figure is slightly higher because of its lower propensity to import, although higher tax rates probably reduce the effect of this differential.

Finally, the multipliers for the effect of an increase in exports on the trade balance are similar for both countries. It is noteworthy that the initial increase in exports of £ 1 million is reduced to less than £ 0.5 million by the induced expansion in imports. The slightly smaller trade balance effect for the UK results from the higher income effect and the consequent larger expansion in imports.

The situation analyzed so far is artificial because it assumes a once and for all increase in exports to a new level which is forever maintained thereafter. A more likely situation might occur if there was a steady increase in exports over the period. The results in Table 1 can be combined to provide impact multipliers for such a situation. Results for the effect of a continual £ 1 million per quarter increase on the indicators of the balance of trade are presented in Table 6.4.

Table 6.4. Effect of continual £ 1 million increase in exports to the rest of the world on the indicators of the balance of trade £ million

I	0.75	-0.29	-0.30	-0.29	-0.26	-0.23	-0.19	-0.15
II		0.75	-0.29	-0.30	-0.29	-0.26	-0.23	-0.19
III			0.75	-0.29	-0.30	-0.29	-0.26	-0.23
IV				0.75	-0.29	-0.30	-0.29	-0.26
V					0.75	-0.29	-0.30	-0.29
VI						0.75	-0.29	-0.30
VII							0.75	-0.29
VIII								0.75
Total IBT	0.75	0.46	0.16	-0.13	-0.39	-0.62	-0.81	-0.96
I	0.61	-0.26	-0.17	-0.12	-0.09	-0.06	-0.05	-0.03
II		0.61	-0.26	-0.17	-0.12	-0.09	-0.06	-0.05
III			0.61	-0.26	-0.17	-0.12	-0.09	-0.06
IV				0.61	-0.26	-0.17	-0.12	-0.09
					0.61	-0.26	-0.17	-0.12
						0.61	-0.26	-0.17
							0.61	-0.26
								0.61
Total UBT	0.61	0.35	0.18	0.06	-0.03	-0.09	-0.14	-0.17

Reading down the first column in Table 6.4are the quarters when the increase in exports occurred. The effect of that increase in exports on the trade balance in each of the succeeding quarters during the eight-quarter period is found by reading across the row. Reading across the "Total IBT" row gives the effect in each quarter of all increases in Irish exports to the rest of the world on the Irish trade balance that have taken place by the end of that quarter. A similar interpretation applies to the "Total UBT" row.

It appears from this table that the trade balance deteriorates even when exports are rising at a constant rate. The reason for this is the large increase in income over the remaining quarters as a result of the increase in exports. The high income elasticity of imports (close to two for Ireland) implies that the increases in income will bring about increases in imports which will eventually be larger than the increases in exports. Exports must increase at an increasing rate to make it possible to maintain the trade balance. On the other hand, the rate of growth of exports required may be infeasible in which case some policy action may be required to shift the structural coefficients in the import functions. This problem could not be investigated in detail, but preliminary results indicate that a moderate rate of growth in exports would prevent a deteriorating trade balance.

Illustration of a Simulation Procedure

The procedure adopted to investigate the effect of increases in automomous exports at increasing rates was to select an arbitrary Y_0

vector and eight X_t vectors and to simulate the model. Y_0 and X_1 were inserted into

$$Y_t = \Pi_1 Y_0 + \Pi_2 X_t$$

to give an estimated Y_1. This estimated Y_1 and X_2 were then inserted to provide an estimated Y_2 and so on.

Table 6.5. Initial values for the endogenous variables £ million

IGNP	825	ITE	103	UMC	1910
IC	609	ITY	60	UMPD	470
II	174	ID	60	UMPN	2700
IMC	68	INI	115	UMS	1621
IMPD	47	IK	950	UTE	4351
IMPN	167	IBT	41	UTY	3628
IMS	23	UGNP	30649	UD	2410
IXC	58	UC	20350	UNI	3390
IXPN	28	UI	5800	UK	34108
				UBT	4499

The arbitrary Y_0 was selected close to the 1963 IV values by modifying the results predicted by a trend at 1963 IV. The trend results for X_t were also modified to provide X_t increasing at an increasing rate. The initial vector Y_0 which was selected is presented in Table 6.5 (above) and the selected X_t vectors are presented in Table 6.6.

Table 6.6. Arbitrary values for autonomous exports £ million

	I	II	III	IV	V	VI	VII	VIII
IA	270	272	275	279	284	290	297	305
UB	11,200	11,250	11,350	11,500	11,700	11,950	12,250	12,600

It is helpful to convert these eight quarterly values to an equivalent annual rate of growth for the purposes of comparison. Recalling that each quarterly value is expressed at an annual rate, this can be done by calculating the average of the first four quarters and the average of the last four quarters and finding their percentage difference. Thus, the values selected in Table 6.6 imply annual growth rates of 7.3% for Irish and 7.1% for UK autonomous exports. Both variables increase at increasing rates.

Although these values for the initial vector and exogenous variables were chosen to be close to their 1963 IV values, their arbitrary nature cannot be overemphasized. It will become clear from the simulations presented below that the results are highly sensitive to the chosen values. This is aside from their sensitivity to the estimated coefficients of the model. Only after considerable experience with different sets of arbitrary values and estimated coefficients will it become possible to generate sufficiently "firm" conclusions that can provide a basis for a policy recommendation or suggest modifications of the economic specification of the model. This researcher has only made a start towards gaining the necessary experience but the results so far are sufficiently revealing to warrant their inclusion in the study. They provide strong evidence of the dependence of the Irish economy on UK economic conditions and illustrate the problems encountered in simulating with a macroeconometric model. Nevertheless, in order to remind the reader of the arbitrary nature of the initial and exogenous values they are repeated in each table of results.

The results of simulating the model using the exogenous values of Table 6.6 are presented in Table 6.7. It is evident from the first row that the growth rate implied by the simulation for Irish real GNP is unreasonably high. Taking the average of the first four quarters and comparing it to the average of the last four quarters, the simulation provides a growth rate of Irish GNP of about 8% per annum.

The source of this unreasonably high growth rate is the failure to consider the effect of the growth in Irish exports to the UK on Irish GNP. Adding the solution values for Irish exports to the UK to the arbitrarily chosen values for Irish autonomous exports, and comparing the annual averages, Irish total exports are seen to grow at 10 percent per annum. This reflects the growth rate of Irish exports to the UK of 18% per annum.

It is not clear why the model yields this high growth rate. There appears to be evidence of structural change at the end of 1964 when the UK special import levy was imposed. The levy was designed to reduce the propensity to import, that is, the slopes of the UK import functions. A dummy was incorporated in the consumer imports function but this shifted the intercept, not the slope. There is also some evidence that the slopes of Irish export functions changed during the levy (Baker 1969). It may have

Table 6.7. Simulation of 7% increases in autonomous exports £ million

	Y_0	I	II	III	IV	V	VI	VII	VIII
IA	268	270	272	275	279	284	290	297	305
IGNP	832	842	851	862	875	891	910	932	959
IC	609	616	622	628	634	642	650	660	671
II	174	179	183	188	194	201	209	219	233
IMC	68	71	73	75	77	80	82	85	89
IMPD	47	48	49	49	50	52	53	55	57
IMPN	167	169	171	174	176	179	182	187	192
IMS	23	24	24	25	26	27	28	29	31
IXC	58	59	61	63	66	69	73	76	80
IXPN	28	29	30	31	32	33	34	36	38
ITE	103	103	106	108	111	114	118	122	127
ITY	60	60	64	66	68	71	75	80	85
ID	60	60	61	62	63	64	65	66	67
INI	115	119	123	126	131	137	144	153	165
IK	950	1069	1192	1318	1449	1586	1730	1883	2048
IBT	49	47	45	46	47	49	51	53	55
UGNP	30649	31118	31474	31845	32272	32781	33383	34105	34941
UC	20350	20600	20826	21045	21265	21494	21740	22010	22311
UI	5800	6060	6265	6458	6675	6940	7268	7670	8151
UMC	1860	1883	1908	1932	1956	1982	2009	2039	2072
UMPD	470	491	524	561	604	655	715	787	870
UMPN	2700	2731	2781	2842	2915	3001	3103	3225	3368
UMS	1621	1638	1655	1673	1693	1716	1742	1774	1811
UTE	4351	4247	4355	4455	4554	4655	4761	4877	5004
UTY	3628	3296	3442	3521	3610	3719	3854	4017	4214
UD	2410	2360	2391	2484	2459	2494	2532	2573	2616
UNI	3390	3700	3873	4034	4217	4446	4736	5097	5535
UK	34108	37803	41681	95715	49932	54377	59113	64211	697461
UBT	4499	4458	4383	4342	4332	4347	4380	4425	4479
UB	11150	11200	11250	11350	11500	11700	11950	12250	12600

been that the Irish share in UK imports increased because of a more effective Irish compensatory program of aid to exports. Future research with the model will throw more light on this question.

In the meantime, to reduce the distortions caused by the overestimation of exports to the UK, it is evident that the growth rate in autonomous exports should be selected so as to constrain total exports to a rise of 7%. A second set of values for Irish autonomous exports was chosen therefore and is presented in Table 6.8. The values continue to increase at an increasing rate.

Table 6.8. Second selection of arbitrary values for Irish autonomous exports £ million

I	II	III	IV	V	VI	VII	VIII
270	270.7	272.1	274.2	277	280.5	284.7	289.6

The second choice of arbitrary values for Irish autonomous exports leaves the solution values for UK endogenous variables and Irish exports to the UK unchanged. The new solution values for the remaining Irish variables are presented in Table 6.9.

The results imply that Irish GNP grows at an annual rate of 5.4% which is high but feasible. The UK figure is somewhat higher, 6.7%. Both balance of trade indicators fall in the first year and then assume steady growth. This corresponds to the small increase in exports in the initial quarters although the initial values for imports may have been set at too high a level. The simulation implies, however, that for both countries increasing exports at an increasing rate will lead to an ever more favorable

Table 6.9. Simulation with 7% growth in total Irish exports £ million

	Y_o	I	II	III	IV	V	VI	VII	VIII
IA	268	270	270.7	272.1	274.2	277	280.5	284.7	289.6
IGNP	832	842	849	857	866	877	890	906	925
IC	609	616	622	627	631	637	643	650	658
II	174	179	183	187	190	194	199	205	213
IMC	68	71	73	75	76	78	80	82	85
IMPD	47	48	48	49	50	51	52	53	55
IMPN	167	169	171	173	175	177	179	182	185
IMS	23	24	24	25	26	26	27	28	29
ITE	103	103	106	108	110	113	115	118	122
ITY	60	60	63	65	66	69	71	74	78
ID	60	60	61	62	63	64	65	66	67
INI	115	119	122	125	128	131	134	139	146
IK	950	1069	1191	1316	1443	1574	1708	1848	1994
IBT	49	47	44	44	45	46	49	51	54

trade balance without an explosive growth rate in GNP.

Consider now a situation in which there is a reduction in the world demand for UK exports so that they experience a slower rate of growth. A second selection of arbitrary values for UK exports is presented in Table 6.10. In this selection exports continue to grow at an increasing rate but the annual rate is now only 4.2%. For simplicity, the growth rate of Irish autonomous exports is assumed to be unchanged, although in reality

Table 6.10. Second selection of arbitrary values for UK exports £ million

	I	II	III	IV	V	VI	VII	VIII
UB	11,200	11,240	11,320	11,420	11,560	11,700	11,840	11,988

a reduction might be expected. The results of the simulation are presented in Table 6.11.

The growth rate of real GNP has been considerably reduced for the UK (from 6.7% to 4.4%) and slightly reduced for Ireland (from 5.4% to 4.9%). The Irish trade balance indicator displays the same time path at a slightly lower level. The reduction in the UK balance of trade in the first year is more severe and extends throughout the eight quarters. It is noteworthy that the UK trade balance deteriorates at a diminishing rate suggesting that imports play the role of an automatic stabilizer - the reduction in exports reduces income which eventually reduces imports by more than the reduction in exports. Thus it appears that reductions in exports operate mainly to reduce GNP and not the trade surplus.

In Chapter I the procyclical nature of demand management for small open economies was discussed. A decline in exports was usually accompanied by (domestic) policy actions to reduce aggregate demand and thereby lower imports. The results of this simulation, however, indicate that such action may be unnecessary for balance of payments reasons and would only aggravate the reduction in real GNP due to the decline in exports. (This is not to say that the government should not attempt to prevent the reduction in GNP). The tentative nature of this result cannot be overemphasized. An

Table 6.11. Simulation with 4% increase in UK autonomous exports

	Y_o	I	II	III	IV	V	VI	VII	VIII
IA	268	270	270.7	272.1	274.2	277	280.5	284.7	289.6
IGNP	832	842	849	857	866	876	888	901	917
IC	609	616	622	26	631	636	642	648	655
II	174	179	183	187	190	194	198	203	210
IMC	68	71	73	75	76	78	80	82	84
IMPD	47	48	48	49	50	51	52	53	54
IMPN	167	169	171	173	175	177	179	181	184
IMS	23	24	24	25	26	26	27	28	29
IXC	58	59	61	63	66	69	72	75	78
IXPN	28	29	30	31	31	33	34	35	36
ITE	103	103	106	108	110	112	115	118	121
ITY	60	60	63	65	66	68	71	74	77
ID	60	60	61	62	63	64	65	66	67
INI	115	119	122	125	127	130	134	138	143
IK	950	1069	1191	1316	1443	1573	1707	1844	1987
IBT	49	47	44	44	45	46	48	50	52
UGNP	30649	31118	31455	31786	32130	32487	32848	33198	33535
UC	20350	20600	20824	21037	21242	21443	21640	21833	22020
UI	5800	6060	6255	6424	6589	6758	6928	7090	7240
UMC	1860	1883	1907	1931	1954	1976	1998	2019	2040
UMPD	470	491	522	556	592	629	668	705	741
UMPN	2700	2731	2779	2836	2898	2964	3032	3101	3168
UMS	1621	1638	1655	1671	1688	1705	1723	1740	1757
UTE	4351	4247	4354	4453	4548	4640	4729	4317	4903
UTY	3628	3296	3441	3512	3585	3664	3746	3829	3909
UD	2410	2360	2391	2424	2458	2493	2530	2567	2605
UNI	3390	3700	3864	3999	4131	4265	4399	4523	4635
UK	34108	37808	41672	45671	49802	54066	58465	62988	67623
UBT	4499	4458	4377	4326	4299	4286	4280	4275	4274
UB	11150	11200	11240	11320	11430	11560	11700	11840	11980

examination of its robustness would be an extremely useful project for further research.

Now consider the effect of a policy response on the part of the British Authorities to the deterioration in exports. A very large number of such responses can be analyzed by the model. Only one simple case is presented here. It is assumed that the UK policymakers foresee the reduction in exports (the decision lag is negative) and take steps to reduce consumer imports. Such steps might involve an import levy and would therefore also increase taxes on expenditure. It is most likely that the tax change will involve an increase in rates, although exemptions (represented by the intercept) may also change. For simplicity, it will be assumed here that only the slopes are changed. The consumer imports and taxes on expenditure functions are now (arbitrarily) chosen to be

$$UMC = -400 + 0.1102\ UC$$

$$UTE = -4969 + 0.22\ UC + 0.28\ UC_{-1}$$

The results of the simulation after this action are presented in Table 6.12.

UK consumer imports now grow at 4.4% instead of the previous 4.7% and the growth rate of UGNP is considerably reduced (from 4.4% to 2.9%). The UK balance of trade is greatly improved with the size of the surplus in the second year exceeding that reached when the growth rate in exports was 7%.

More interesting is the effect on the Irish variables. It should be recalled that the model appears to have a tendency to overestimate Irish exports to the UK so that the sensitivity of Irish aggregates to changes in UK conditions is probably overstated.

The result of the UK policy action is to more than halve the growth rate of Irish consumer exports (from 18% to 8.5%) and to almost halve the growth rate of Irish GNP (from 4.9% to 2.8%). The deterioration in the Irish trade balance during the first year is more severe but by the end of the second year the surplus is higher than before the UK policy action.

Table 6.12. Simulation after UK action to reduce consumer imports £ million

	Y_o	I	II	III	IV	V	VI	VII	VIII
IA	268	270	270.7	272.1	274.2	277	280.5	284.7	289.6
IGNP	832	839	843	847	852	857	864	873	883
IC	609	616	620	623	626	629	632	636	641
II	174	178	181	182	183	184	185	186	188
IMC	68	70	72	74	75	76	77	79	80
IMPD	47	48	48	49	49	50	50	51	52
IMPN	167	169	171	172	173	174	175	175	176
IMS	23	24	24	25	25	25	26	26	27
IXC	58	57	58	59	60	61	63	64	66
IXPN	28	29	29	30	31	31	32	33	34
ITE	103	102	105	107	108	110	111	113	115
ITY	60	60	62	63	63	65	66	68	70
ID	60	60	61	62	63	64	65	66	67
INI	115	118	120	121	121	120	120	120	121
IK	950	1068	1188	1309	1430	1550	1670	1790	1911
IBT	49	45	42	41	42	44	48	51	55
UGNP	30649	30937	31116	31298	31507	31744	31999	32257	32514
UC	20350	20452	20572	20686	20798	20912	21028	21147	21266
UI	5800	5963	6045	6103	6167	6249	6344	6444	6544
UMC	1910	1854	1867	1880	1892	1905	1917	1930	1944
UMPD	470	477	493	511	532	556	582	609	637
UMPN	2700	2713	2737	2767	2802	2843	2889	2937	2986
UMS	1621	1633	1643	1652	1662	1673	1685	1697	1710
UTE	4351	5228	5283	5342	5399	5455	5513	5571	5631
UTY	3628	3187	3072	3110	3151	3200	3258	3319	3380
UD	2410	2360	2391	2422	2453	2485	2517	2549	2582
UNI	3390	3603	3654	3681	3714	3764	3828	3895	3962
UK	34108	37711	41365	45046	48761	52525	56353	60248	64210
UBT	4499	4523	4500	4510	4542	4583	4627	4666	4705
UB	11150	11200	11240	11320	11430	11560	11700	11840	11980

This suggests that for Ireland also imports act as a built in stabilizer so that a reduction in exports will eventually lead to a reduction in imports which is larger than the reduction in exports. The policy implication is not to cut imports but again the tentative nature of the result cannot be overemphasized.

Just for interest, a final simulation was made of the case where the Irish authorities did attempt to reduce consumer imports. The functions were changed to

$$IMC = -80.93 + 0.193IC + 0.4415\ IMC_{-1}$$

$$ITE = -183.3 + 0.26IC + 0.2320\ IC_{-1}$$

The results of this simulation are seen in Table 6.13. Consumer imports are reduced from an annual rate of 7% to 4.7% and the trade balance is considerably improved. The growth rate of GNP is reduced very slightly from 2.83% to 2.81%.

A noteworthy feature of this simulation is the stagnation of investment (with net investment showing a slight decline) and the consequent stagnation of imports of producer nondurables. The functional dependence of the latter on investment was made on an ad hoc basis after failure to relate them to GNP. It seems likely that the stagnation of producer nondurable imports would not be as great if they were related to GNP. This might make the reduction in GNP more severe and the gains to the trade balance of a smaller magnitude.

In conclusion, the researcher believes that simulation of the Anglo-Irish model using the procedure outlined above is a useful exercise. Greater experience with the model is likely to yield results of considerable interest to the policy maker and to suggest useful projects to the economic researcher.

Table 6.13. Simulation after Irish action to reduce consumer imports
£ million

	Y_0	I	II	III	IV	V	VI	VII	VIII
IA	268	270	270.7	272.1	274.2	277	280.5	284.7	289.6
IGNP	832	838	841	845	850	855	862	871	881
IC	609	611	614	616	618	620	623	627	631
II	174	178	180	182	182	183	183	184	186
IMC	68	67	67	68	68	69	70	71	72
IMPD	47	48	48	49	49	50	50	51	52
IMPN	167	169	171	172	173	174	174	174	175
IMS	23	24	24	25	25	25	26	26	27
ITE	103	117	118	119	120	121	123	124	126
ITY	60	58	58	59	60	61	62	64	66
ID	60	60	61	62	63	64	65	66	67
INI	115	118	119	120	120	119	119	119	119
IK	950	1068	1187	1307	1487	1664	1664	1783	1902
IBT	49	49	48	48	50	56	56	60	64

The model, however, will remain only a tool. The sensitivity of the results to the data, economic specification, statistical technique and simulation assumptions is so great that considerable care should be exercised in their interpretation. The model should be continually respecified and reestimated in the light of experience and new technology in order to increase its accuracy and discover its properties.

CHAPTER VII. SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

A fall in Irish exports is often accompanied by economic policies designed to reduce imports in order to maintain balance of payments equilibrium. Increased knowledge of the impact of economic policy instruments might reduce this procyclical nature of Irish demand management policy. Such knowledge can be generated by a macroeconometric model.

A quarterly rather than annual time unit was chosen for the macroeconometric model estimated in this study. While annual models have their uses, the quarterly time unit has three special advantages. First, quarterly models indicate the deterioration of economic conditions more rapidly than annual models. Second, the behavior of economic units becomes obscured as the time unit lengthens. Thus quarterly models are more useful for analyzing economic behavior. Third, regression models are estimated on the assumption of constant structure. Quarterly models provide a relatively large number of observations over a short time period. The hypothesis of constant structure is more easily maintained for the shorter time period. These advantages were believed by the researcher to outweigh the greater problems associated with quarterly models. These problems included the limited availability of data, its lower reliability and the difficulties associated with seasonal variation.

The unavailability of Irish quarterly national accounts was solved by using the short term economic indicators to interpolate the annual data. The annual values of the short term indicators were regressed against the annual national accounts figures to give the equation

$$Y_t = a + bX_t$$

where Y_t is the annual national accounts magnitude and X_t is the annual short term indicator. The quarterly values of the short term indicators were seasonally adjusted, converted to annual rates, and inserted in the above equation. The corresponding forecasts of Y_t were interpreted as quarterly estimates of the national accounts magnitude, seasonally adjusted at annual rates. Where appropriate indicators were not available, quarterly values were estimated by fitting a nonlinear trend to the annual values using a technique developed by Sandee and Lisman (1962).

The availability of data imposed five constraints on the model. First, the sample period 1961-68 corresponds to the first year for which the retail sales index was available and the last year for which annual national accounts were available. Second, only the expenditure side of national accounts could be estimated because of the lack of information on agricultural income and output. On the expenditure side, no information was available on inventories so that inventory investment could not be considered explicitly. Limited information on financial variables, especially the capital account of the balance of payments, prevented their inclusion in the model. This prevented adequate consideration of housing investment, for example. Finally, certain limitation in data needed for the foreign sector limited the disaggregation made therein. This was especially true of price indices.

The foreign sector is the most important sector of the estimated model because of Ireland's dependence on trade. Four import functions were included and two export functions. Because of the importance of the United Kingdom as an export market, Irish exports were functionally related to British imports. The UK variables might have been taken to be exogenous but the availability of quarterly national accounts made it practicable to estimate a macroeconometric model of the entire Anglo-Irish economy. Such a model can be used to examine how economic fluctuations are transmitted from the United Kingdom to Ireland. The estimated model is therefore an example of a transmission model of international trade.

The review of literature begins by reviewing transmission models of international trade. It includes the work of Metzler (1950), Neisser and Modigliani (1953), Rhomberg and Boisseneault (1964), Adams et al. (1969), Resnick (1968). Certain macroeconometric studies of the Irish and U.K. economies are then reviewed. Irish studies included the work of Leser (1967a) and Walsh (1970), Leser (1967b) and McAleese (1970). Most British work is too disaggregated but the Klein et al. (1961) model and Balopolous (1967) model were reviewed in some detail.

Chapter IV provides the theoretical basis and empirical estimates of the model. The model considers only one transmission mechanism, that via trade flows. Transmission via invisible exports, financial flows, factor movements and import prices was neglected. The feedback from Irish economic conditions to the UK was believed to be negligible.

The estimated model consisted of twenty structural equations and ten identities determining 30 endogenous variables. Ten current exogenous variables entered the model together with 18 lagged endogenous variables making a total of 28 predetermined variables. The twenty structural equations included 8 import functions, 2 export functions, 2 consumption functions, 2 investment functions, 2 depreciation and 4 tax functions. Each country had 5 identities determining GNP, personal income, disposable income, net investment and the capital stock. Minor changes were made to improve the fit of the estimated model. Nineteen dummy variables were included for structural changes.

The model was estimated using ordinary least squares mainly for computational convenience. It was not felt that the statistical advantage of simultaneous methods outweighed the extra computational burden. The results appear satisfactory by the criteria of $\bar{R}^2$, Durbin-Watson test, t values and so on. No price terms were significant, however.

In Chapter V the reduced form of the model is presented. Inserting the exogenous variables provided a test of the predictive ability of the model during the sample period. The forecasts were regressed against the actual values and tests were made of the accuracy of the fit. While the results were acceptable overall, there was room for improvement in some equations.

Multipliers were presented in the first half of Chapter VI. The second half contains an illustration of a simulation procedure. The reduced form of the model can be written in matrix form as

$$Y_t = \Pi_1 Y_{t-1} + \Pi_2 X_t$$

where Y_t is a vector of endogenous variables at time t and X_t a vector of exogenous variables. Inserting eight values of X_t and choosing an initial vector for Y_{t-1}, eight vectors Y_t can be generated. A control solution was obtained with X_t (interpreted as exports) showing steady growth. A slower rate of growth of X_t was then inserted and the two solutions compared. Finally the coefficients in Π_2 were altered as a result of a UK policy decision to reduce imports and the result was analyzed.

The most important conclusion of the study is that a quarterly macroeconometric model of the Irish economy can be estimated which will provide useful information to the policymaker. Such a model would have to be continuously reestimated and its results interpreted with care. It would help provide explicit formulation of the assumptions behind economic policy and quantitative measures of the interdependence among the various sectors of the economy. This might broaden the horizon of some policymakers. In addition, the model would indicate the after effects of policy measures during the following two years and, in this sense, the model might lengthen the horizon of policymakers.

The model establishes a significant connection between the economies of Ireland and the United Kingdom. Transmission of economic fluctuations is assumed to be one-way so that Ireland is, in effect, treated as a region of the United Kingdom with an unusual degree of political autonomy. While transmission via invisible exports, financial flows, factor movements and import prices were ruled out *a priori*, in order to keep the model of manageable size, it was not possible to establish a connection between Irish exports of live animals and producers' durables and UK variables because of the level of aggregation employed. Thus, the model understates the degree of dependence of the Irish economy on the

United Kingdom.

The estimated coefficients of the structural equations are similar to those estimated for other countries so that the results, in some sense, validate the basic data. Thus, it can be concluded that sufficiently accurate interpolations of the annual Irish national accounts data can be made to enable estimation of a macroeconometric model.

Nevertheless, there remains so much room for improvement that it is clear that only a start has been made. The output of econometric research might be viewed as a function of three inputs: data, economic specification and statistical technique. The goals of the research project might be combined conceptually to provide an objective function which must be maximized subject to the constraint of the above production function. The success of the project, therefore, is clearly a function of the quality of the three inputs: data, economic specification, and statistical technique. Suggestions for further research might be conveniently grouped under these three headings.

The quarterly estimates of the Irish national accounts might be improved by increasing their accuracy and extending their coverage. Accuracy might be increased by better and more related series and by a more flexible interpolation procedure. Examination should be made of the residuals of the regression equation employed and the degree of inaccuracy for each year assessed. Some procedure for incorporating the residual into the quarterly estimates might be considered.

The data on trade flows can be improved by using the primary (national) instead of secondary (international) sources. This would permit a more satisfactory level of disaggregation although the disaggregation would be limited by the availability of suitable price deflators.

The economic specification of the model can be improved by considering other transmission mechanisms. This study has demonstrated, however, that useful results can be obtained when only one transmission mechanism is considered. The model can also be improved by incorporation of more accurate lag structures. The results are highly sensitive to the estimated coefficients of the lagged endogenous variables. The Koyck lag distribution was selected for computational convenience. Other distributions might be specified or the Almon technique might be used to allow the data to determine the distribution. Ultimately, variable lags which depend on economic activity will have to be used.

Improved quality of data would enable more sophisticated economic specifications to be used. This applies, particularly, to the investment function where modern theory uses first differences rather than levels of output.

The chief limitation imposed by the statistical technique on the model was the requirement of linearity. Certain functional relationships were clearly nonlinear. This was true of tax functions and functions involving data estimated by the Sandee-Lisman technique. Procedures exist for dealing with nonlinear systems and these might provide a useful avenue of exploration for future research.

The bias introduced by applying ordinary least squares to a simultaneous system ought to be quantified by comparing the results under alternative estimation methods. Insofar as the bias is found to be significant, more complex methods of estimation should be employed.

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APPENDIX A: TABLES OF QUARTERLY ESTIMATES OF IRISH NATIONAL ACCOUNTS 1961-68, SEASONALLY ADJUSTED AT ANNUAL RATES

List of symbols used in the tables in this Appendix:

C = personal expenditure on consumers' goods and services

D = investment in dwellings

DY = personal disposable income

FI = fixed investment

G = net expenditure by public authorities on current goods and services

GNP = expenditure on gross national product

HPD = investment in home produced machinery and equipment

I = gross domestic physical capital formation

M = imports of goods and services excluding factor income flows

MG = imports of goods

MPD = imports of machinery and equipment

MS = imports of services

OBLDG = investment in other building and construction including roads

PY = personal income

TE = taxes on expendture

TY = taxes on income

X = exports of goods and services excluding factor income flows

XG = exports of goods

XS = exports of services

YA = net factor income from abroad

S = value of the physical changes in stocks and work in progress

Table A.1. Quarterly estimates of GNP in current prices seasonally adjusted at annual rates £ million

Year		C	I	G	YA	less X-M	GNP
1961	I	513.4	119.4	78.0	35.8	40.4	706.2
	II	516.4	123.7	81.4	36.7	36.4	720.4
	III	520.0	110.0	82.6	37.6	37.8	712.4
	IV	533.0	122.9	84.6	36.9	28.5	748.9
1962	I	552.9	126.9	86.4	36.9	39.6	763.5
	II	558.3	132.8	88.5	37.1	45.3	771.4
	III	555.3	138.7	90.5	37.0	57.3	764.2
	IV	583.6	148.1	92.4	36.6	59.3	801.4
1963	I	586.0	143.4	94.4	36.0	43.3	816.5
	II	600.5	141.3	95.4	35.4	46.1	826.5
	III	602.9	163.9	96.0	35.4	45.6	852.6
	IV	623.0	183.7	99.9	36.0	91.4	851.2
1964	I	638.9	182.3	105.8	36.1	73.7	899.4
	II	661.5	209.2	112.4	35.9	74.4	944.6
	III	681.2	187.2	118.0	37.1	72.6	950.9
	IV	691.7	194.9	121.7	39.7	73.7	974.3
1965	I	696.2	215.8	123.7	43.0	98.9	979.8
	II	706.5	263.0	126.0	45.8	115.4	1025.9
	III	709.8	221.6	129.0	46.7	73.5	1033.6
	IV	713.3	214.6	131.1	45.7	62.7	1042.0
1966	I	710.7	196.6	132.4	44.3	51.1	1032.9
	II	719.5	199.1	133.5	43.7	49.4	1046.4
	III	764.1	208.6	134.9	44.0	95.2	1056.4
	IV	772.6	206.4	136.8	45.2	41.2	1119.8
1967	I	772.9	216.2	139.3	45.9	61.9	1112.4
	II	776.1	209.0	140.6	46.2	21.8	1150.1
	III	801.2	215.1	141.8	47.9	34.8	1171.2
	V	814.6	217.2	145.9	50.8	7.1	1221.4
1968	I	836.3	237.6	153.0	54.3	63.5	1217.7
	II	867.8	263.1	161.1	57.3	63.5	1285.8
	III	876.0	275.9	167.8	58.9	88.3	1290.3
	IV	900.9	303.9	172.4	59.1	89.7	1346.6

Table A.1a. Quarterly estimates of GNP in constant (1958) prices seasonally adjusted at annual rates £ million

Year		C	I	G	YA	less X-M	GNP
1961	I	499.9	113.5	74.0	34.9	44.8	677.5
	II	499.4	118.0	74.4	35.6	41.6	685.8
	III	501.0	105.2	74.8	35.9	35.2	681.7
	IV	507.6	114.0	75.3	35.7	25.6	707.0
1962	I	515.3	117.3	76.0	35.7	42.2	702.1
	II	515.0	121.8	76.5	35.8	46.3	702.8
	III	514.2	126.4	77.1	35.7	61.4	692.0
	IV	535.4	133.4	77.8	35.4	64.8	717.2
1963	I	534.2	130.4	78.6	34.9	47.1	731.0
	II	548.9	128.9	79.6	34.5	53.6	738.3
	III	548.1	148.6	80.5	34.5	52.1	759.6
	IV	551.3	162.1	81.1	34.9	95.0	734.4
1964	I	555.6	156.2	81.6	34.8	78.2	750.0
	II	558.2	173.3	82.0	34.6	85.8	762.3
	III	562.1	160.1	82.4	35.6	84.8	755.4
	IV	570.7	163.0	83.1	37.8	79.9	774.7
1965	I	566.5	176.4	84.1	40.6	107.0	760.6
	II	568.8	216.0	85.1	43.0	121.8	791.1
	III	570.6	181.2	86.1	43.7	84.6	797.0
	IV	573.4	172.8	86.7	42.8	73.7	802.0
1966	I	565.8	159.2	86.9	41.4	67.0	786.3
	II	570.1	159.9	86.8	40.8	69.0	788.6
	III	592.3	167.9	86.8	41.1	115.3	772.8
	IV	597.5	160.6	87.5	42.3	58.3	829.6
1967	I	592.3	165.1	88.9	43.4	86.3	803.4
	II	589.3	157.7	89.8	44.1	48.4	832.5
	III	606.5	163.9	90.5	45.2	56.4	849.7
	IV	608.4	162.4	92.1	46.6	38.7	870.8
1969	I	613.1	178.7	94.8	48.1	83.2	851.5
	II	630.7	197.6	97.5	49.4	85.2	890.0
	III	631.6	206.2	99.7	50.7	98.6	889.6
	IV	636.7	226.1	102.1	51.9	105.0	911.8

Table A.2. Quarterly estimates of I in current prices seasonally adjusted at annual rates

Year		D	OBLDG	MPD	HPD	FI	S	I
1961	I	17.1	37.7	34.9	17.1	106.8	12.6	119.4
	II	19.1	39.0	35.8	19.1	107.7	16.0	123.7
	III	17.9	41.2	32.2	17.9	105.1	4.9	110.0
	IV	18.5	44.1	35.8	18.5	116.0	6.9	122.9
1962	I	20.3	47.0	35.8	20.3	120.7	6.2	126.9
	II	20.5	49.4	35.5	20.5	123.7	9.1	132.8
	III	20.4	51.4	38.8	20.4	130.3	8.4	138.7
	IV	18.8	53.0	43.6	18.8	135.6	12.5	148.1
1963	I	21.3	54.3	40.9	21.3	136.8	6.6	143.4
	II	16.0	55.7	40.2	16.0	130.1	11.2	141.3
	III	24.6	57.9	48.5	24.6	150.9	13.0	163.9
	IV	25.4	61.0	55.9	25.4	168.9	14.8	183.7
1964	I	20.6	64.9	46.4	20.6	159.7	22.6	182.3
	II	31.4	68.4	59.0	31.4	189.7	19.5	209.2
	III	25.6	70.1	49.8	25.6	168.6	18.6	187.2
	IV	24.7	71.4	50.5	24.7	178.0	16.9	194.9
1965	I	27.9	72.1	51.2	27.9	194.4	21.4	215.8
	II	27.2	73.4	85.8	27.2	233.8	29.2	263.0
	III	20.5	74.3	59.0	20.5	192.4	29.2	221.6
	IV	22.9	74.9	53.0	22.9	194.1	20.5	214.6
1966	I	21.0	75.3	54.5	21.0	183.3	13.3	196.6
	II	27.1	75.9	57.4	27.1	199.8	-0.7	199.1
	III	30.7	76.8	60.1	30.7	198.2	10.4	208.6
	IV	18.8	78.0	59.5	18.8	194.9	11.5	206.4
1967	I	23.0	78.2	59.5	23.0	210.2	6.0	216.2
	II	26.1	78.3	53.5	26.1	203.0	6.0	209.0
	III	25.7	80.6	70.5	25.7	218.0	-2.9	215.1
	IV	26.6	85.7	53.5	26.6	216.3	0.9	217.2
1968	I	28.0	89.8	64.5	28.0	223.6	14.0	237.6
	II	29.8	93.9	75.7	29.8	237.4	25.7	263.1
	III	27.4	96.9	85.0	27.4	852.2	23.7	275.9
	IV	27.0	99.1	96.4	27.0	272.6	31.3	303.9

Table A.2a. Quarterly estimates of I in constant (1958) prices

Year		D	DBLDC	MPD	HPD	FI	S	I
1961	I	15.0	37.1	34.0	16.8	102.9	10.6	113.5
	II	13.6	38.0	24.5	18.5	104.6	13.4	118.0
	III	13.6	39.4	30.9	17.3	101.2	4.0	105.2
	IV	15.2	41.2	34.1	17.7	108.2	5.8	114.0
1962	I	15.2	43.0	34.0	19.3	111.5	5.8	117.3
	II	15.4	44.7	33.6	19.4	113.1	8.7	121.8
	III	16.1	46.3	36.4	19.3	118.1	8.3	126.4
	IV	16.3	47.7	41.1	17.6	121.9	11.5	133.4
1963	I	16.3	49.2	38.6	20.0	124.1	6.3	130.4
	II	15.4	50.8	37.8	15.0	119.0	9.9	128.9
	III	16.2	52.3	45.7	23.0	137.2	11.4	148.6
	IV	19.3	53.8	52.4	23.6	149.1	13.0	162.1
1964	I	19.8	55.6	42.8	18.9	137.1	19.1	156.2
	II	21.4	57.4	53.5	24.4	156.7	16.6	173.3
	III	17.6	58.4	45.1	23.1	144.2	15.9	160.1
	IV	21.7	58.6	45.7	22.3	148.3	14.7	163.0
1965	I	28.4	59.1	45.7	25.0	158.2	18.2	176.4
	II	31.1	59.9	76.5	24.2	191.7	24.3	216.0
	III	25.6	60.1	52.8	18.3	156.8	24.4	181.2
	IV	28.4	59.7	47.0	20.3	155.4	17.4	172.8
1966	I	22.2	59.3	47.7	18.4	147.6	11.6	159.2
	II	26.1	59.0	49.9	23.7	158.7	1.2	159.9
	III	21.3	59.1	52.0	26.8	159.1	8.8	167.9
	IV	25.6	59.4	50.9	16.1	152.0	8.6	160.6
1967	I	32.5	59.2	50.7	19.7	162.1	3.0	165.1
	II	29.5	58.8	45.5	22.2	156.0	1.7	157.7
	III	27.1	59.9	59.8	21.9	168.7	-4.8	163.9
	IV	33.2	62.5	45.2	22.6	163.5	-1.1	162.4
1968	I	27.2	65.0	53.6	23.5	169.3	9.4	178.7
	II	25.3	67.0	62.2	24.8	179.3	18.3	197.6
	III	28.2	69.0	69.1	22.6	188.9	17.3	206.2
	IV	32.9	71.0	77.4	21.9	203.2	22.9	225.1

Table A.3. Quarterly estimates of X-M in current prices seasonally adjusted at annual rates £ million

Year		XG	MG	XS-MS	X-M
1961	I	174.6	-258.4	43.7	-40.4
	II	181.6	-263.2	46.0	-36.4
	III	184.8	-270.0	47.4	-37.8
	IV	180.7	-267.2	48.0	-28.5
1962	I	175.9	-264.0	48.5	-39.6
	II	166.9	-261.6	49.4	-45.3
	III	173.8	-281.6	49.9	-57.3
	IV	180.3	-290.8	51.2	-59.3
1963	I	178.0	-273.6	52.3	-43.3
	II	208.0	-307.6	53.5	-46.1
	III	201.2	-302.8	56.0	-45.6
	IV	199.6	-344.8	53.8	-91.4
1964	I	219.6	-348.0	54.7	-73.7
	II	226.4	-355.6	54.9	-74.4
	III	217.2	-346.0	56.2	-72.6
	IV	214.4	-346.8	58.7	-73.7
1965	I	204.8	-365.2	61.5	-98.9
	II	203.6	-382.8	63.8	1115.4
	III	238.4	-377.2	65.3	-73.5
	IV	232.8	-361.6	66.0	-62.7
1966	I	237.2	-354.8	66.6	-51.1
	II	219.2	-336.0	67.4	-49.4
	III	249.6	-413.6	68.8	-95.2
	IV	277.8	-390.4	71.4	-41.2
1967	I	261.2	-395.2	72.1	-61.9
	II	290.4	-385.6	73.4	-21.8
	III	284.0	-394.4	75.7	-34.8
	IV	302.0	-388.0	78.9	-7.1
1968	I	303.6	-450.0	83.0	-63.5
	II	342.4	-492.8	86.9	-63.5
	III	326.4	-503.2	88.4	-88.3
	IV	359.2	-536.8	88.0	-89.7

Table A.3a. Quarterly estimates of X-M in constant (1958) prices, seasonally adjusted at annual rates ₤ million

Year		XG	MG	XS-MS	X-M
1961	I	172.9	258.4	40.7	-44.8
	II	179.8	263.2	41.8	-41.6
	III	186.7	264.7	42.8	-35.2
	IV	182.5	252.2	44.1	-25.6
1962	I	175.9	264.0	45.9	-42.2
	II	165.2	259.0	47.5	-46.3
	III	172.1	281.6	48.1	-61.4
	IV	178.5	290.8	47.5	-64.8
1963	I	174.5	268.2	46.6	-47.1
	II	201.9	301.6	46.1	-53.6
	III	195.3	294.0	46.6	-52.1
	IV	191.9	334.8	47.9	-95.0
1964	I	207.2	334.6	49.2	-78.2
	II	205.8	341.9	50.3	-85.8
	III	197.5	332.7	51.2	-84.0
	IV	198.5	330.3	51.9	-79.9
1965	I	187.8	347.8	53.0	-107.0
	II	185.1	361.1	54.1	-121.8
	III	216.7	355.8	54.5	-84.6
	IV	213.6	341.1	53.8	-73.7
1966	I	215.6	334.7	52.1	-67.0
	II	194.0	314.0	51.0	-69.0
	III	222.9	390.2	52.0	-115.3
	IV	254.9	368.3	55.1	-58.3
1967	I	231.2	376.4	58.9	-86.3
	II	257.0	367.2	61.8	-48.4
	III	255.9	375.6	63.3	-56.4
	IV	267.3	369.5	63.5	-38.7
1968	I	255.1	401.8	63.5	-83.2
	II	283.0	432.3	64.1	-85.2
	III	269.8	433.8	65.4	-98.6
	IV	294.4	466.8	67.4	-105.0

Table A.4. Quarterly estimates of DY in current prices, seasonally adjusted at annual rates £ million

Year		GNP	Tr	PY	TY	DY
1961	I	706.2	107.5	598.7	28.0	570.7
	II	720.4	110.0	610.4	30.9	579.5
	III	712.4	116.4	596.0	30.9	565.1
	IV	748.9	111.2	637.7	34.3	603.4
1962	I	763.5	119.9	643.6	34.6	609.0
	II	771.4	113.6	657.8	35.2	622.6
	III	764.2	114.8	649.4	36.7	612.7
	IV	801.4	122.9	678.5	36.9	641.6
1963	I	816.5	121.0	695.5	39.6	655.9
	II	826.5	124.8	701.7	38.3	663.4
	III	852.6	127.2	72,54	38.7	686.7
	IV	851.2	132.3	718.9	42.8	676.1
1964	I	899.4	137.9	761.5	45.1	716.4
	II	944.6	148.7	795.9	48.5	747.4
	III	950.9	151.3	799.6	51.5	748.1
	IV	974.3	155.4	818.9	51.5	767.4
1965	I	979.8	159.6	820.2	50.9	769.3
	II	1025.9	165.6	860.3	53.4	806.9
	III	1033.6	161.6	872.0	53.9	818.1
	IV	1042.0	168.7	873.3	60.0	813.3
1966	I	1032.9	175.4	857.5	62.9	794.6
	II	1046.4	181.6	864.8	63.5	801.3
	III	1056.4	191.2	865.2	71.0	794.2
	IV	1119.8	189.5	930.3	71.6	858.7
1967	I	1112.4	202.0	910.4	74.2	836.2
	II	1150.1	204.3	945.8	84.7	861.1
	III	1171.2	206.5	964.7	82.3	882.4
	IV	1221.4	209.9	1011.5	84.9	926.6
1968	I	1217.7	215.9	1001.8	85.4	916.4
	II	1285.8	227.5	1058.3	83.6	974.7
	III	1290.3	233.7	1056.6	90.6	966.0
	IV	1346.6	243.8	1102.8	100.1	1002.7

APPENDIX B: ACTUAL AND PREDICTED VALUES FOR THE TWENTY-TWO ENDOGENOUS VARIABLES OF THE MODEL DURING THE SAMPLE PERIOD, TABULATED AND GRAPHED

List of symbols used in this Appendix:

A = actual value in constant (1963) prices often after minor adjustments for special events such as strikes and tax changes

P = predicted value corresponding to the actual value defined above. The prediction was obtained by inserting the actual values of the exogenous variables into the reduced form of the model as described in Chapter V

R = residual = actual value minus the predicted value

Table B.1. Actual and predicted values for Irish consumption 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	552.0	555.6	-3.6	-0.7
	III	553.7	566.2	-12.5	-2.3
	IV	561.1	564.2	-3.1	-0.6
1962	I	569.6	562.6	7.0	1.2
	II	569.2	570.7	-1.5	-0.3
	III	568.3	571.3	-3.0	-0.5
	IV	591.8	571.0	20.8	3.5
1963	I	590.5	590.1	-0.4	-0.1
	II	606.7	591.3	15.4	2.5
	III	605.8	609.0	-3.2	-0.5
	IV	609.4	607.8	-1.6	-0.3
1964	I	614.1	618.4	-4.3	-0.7
	II	617.0	616.4	0.6	0.1
	III	621.3	620.7	0.6	0.1
	IV	630.8	626.4	4.4	0.7
1965	I	626.1	629.9	-3.8	-0.6
	II	628.7	626.3	2.4	0.4
	III	630.7	631.5	0.8	-0.1
	IV	633.8	635.9	-2.1	-0.3
1966	I	625.4	631.5	-6.1	-1.0
	II	630.2	633.7	-3.5	-0.6
	III	654.6	628.3	26.3	4.0
	IV	660.4	655.2	5.2	0.8
1967	I	654.7	662.8	-8.1	-1.2
	II	651.4	661.7	-10.3	-1.6
	III	670.4	666.6	3.8	0.6
	IV	672.5	681.3	-8.8	-1.3
1968	I	677.7	667.8	9.9	1.5
	II	697.1	686.0	11.1	1.6
	III	681.1	690.9	-9.8	-1.4
	IV	703.7	688.9	14.8	2.1

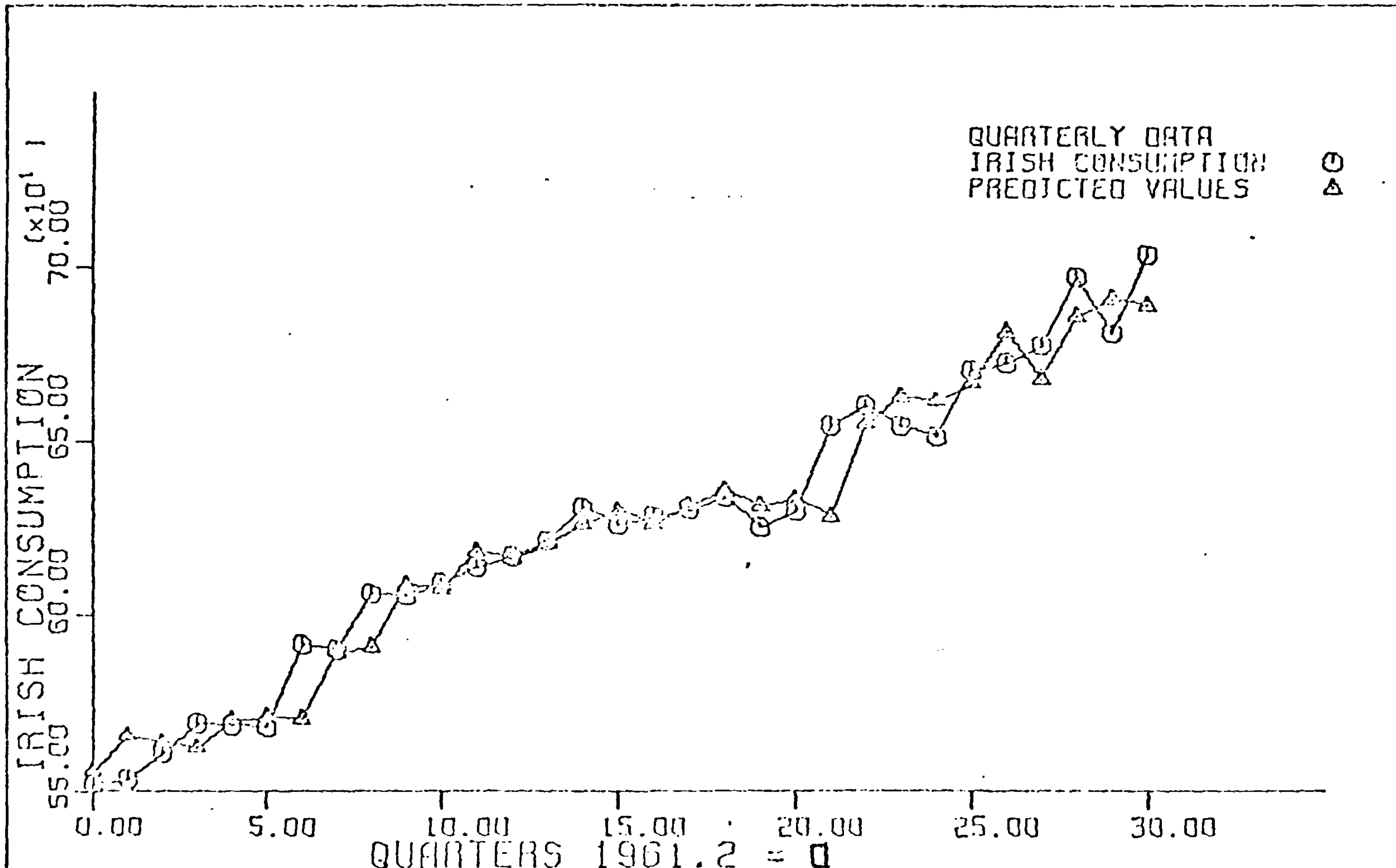

Figure B.1. Actual and predicted Irish consumption, 1961 II - 1968 IV £ million

Table B.2. Actual and predicted values for Irish investment 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	130.7	125.1	5.6	4.3
	III	116.6	138.6	-22.0	-18.9
	IV	126.3	123.1	3.2	2.5
1962	I	130.0	126.1	3.9	3.0
	II	135.0	130.9	4.1	3.0
	III	140.0	134.8	5.2	3.7
	IV	147.8	137.7	10.1	6.8
1963	I	144.5	150.1	-5.6	-3.9
	II	142.8	146.4	-3.6	-2.5
	III	164.7	153.1	11.6	7.0
	IV	179.6	169.4	10.2	5.7
1964	I	173.1	187.3	-14.2	-8.2
	II	192.0	177.1	14.9	7.8
	III	177.4	193.7	-16.3	-9.2
	IV	180.6	183.1	-2.5	-1.4
1965	I	195.5	183.1	12.4	6.3
	II	205.0	192.4	12.6	6.2
	III	200.8	202.3	-1.5	-0.8
	IV	191.5	200.8	-9.3	-4.9
1966	I	173.4	187.5	-11.1	-6.3
	II	177.2	179.4	-2.2	-1.2
	III	186.0	171.7	14.3	7.7
	IV	178.0	189.6	-11.6	-6.5
1967	I	182.9	187.3	-4.4	-2.4
	II	174.7	192.0	17.3	-9.9
	III	181.6	188.8	-7.2	-4.0
	IV	179.9	198.2	-18.3	-10.2
1968	I	198.0	182.0	16.0	3.1
	II	218.9	208.0	10.9	5.0
	III	228.5	221.4	7.1	3.1
	IV	250.5	232.8	17.7	7.1

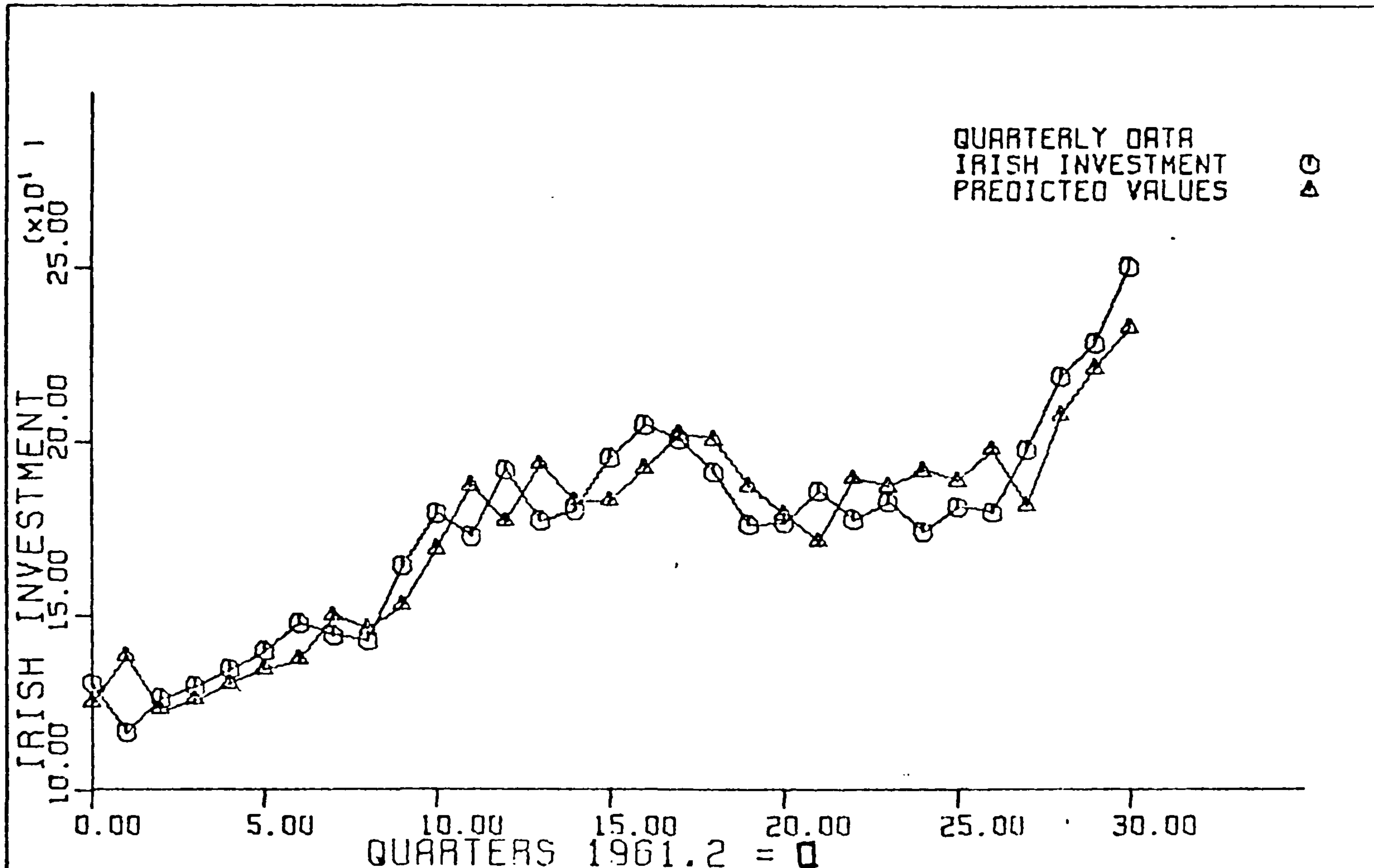

Figure B.2. Actual and predicted Irish investment, 1961 II - 1968 IV £ million

Table B.3. Actual and predicted values for Irish consumer imports 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	52.9	52.9	0	0
	III	57.3	54.0	3.3	2.8
	IV	57.5	55.5	2.0	1.6
1962	I	57.6	55.3	2.3	1.8
	II	57.9	57.0	0.9	0.7
	III	56.5	57.2	-0.7	-0.5
	IV	60.3	56.5	3.8	2.6
1963	I	62.8	62.0	0.8	0.6
	II	63.7	63.3	0.4	0.3
	III	64.0	67.2	-3.2	-1.9
	IV	70.4	67.0	3.4	1.9
1964	I	67.5	72.0	-4.5	-2.6
	II	71.6	70.3	1.3	0.7
	III	67.6	73.0	-5.4	-3.0
	IV	71.3	72.3	-1.0	-0.6
1965	I	74.5	74.7	-0.2	-0.1
	II	76.0	75.4	0.6	0.3
	III	79.8	77.1	2.7	1.4
	IV	76.8	79.6	-2.8	-1.5
1966	I	74.9	77.4	-2.5	-1.4
	II	69.2	77.0	-7.8	4.4
	III	88.2	73.4	14.8	8.0
	IV	82.2	87.1	-4.9	-2.8
1967	I	81.8	86.0	-4.2	-2.3
	II	76.6	85.6	-9.0	-5.2
	III	81.6	84.2	-2.6	1.4
	IV	80.5	89.3	-8.8	-4.9
1968	I	96.6	86.2	10.4	5.3
	II	99.4	96.9	2.5	1.1
	III	105.2	99.1	6.1	2.7
	IV	110.0	101.3	8.7	3.5

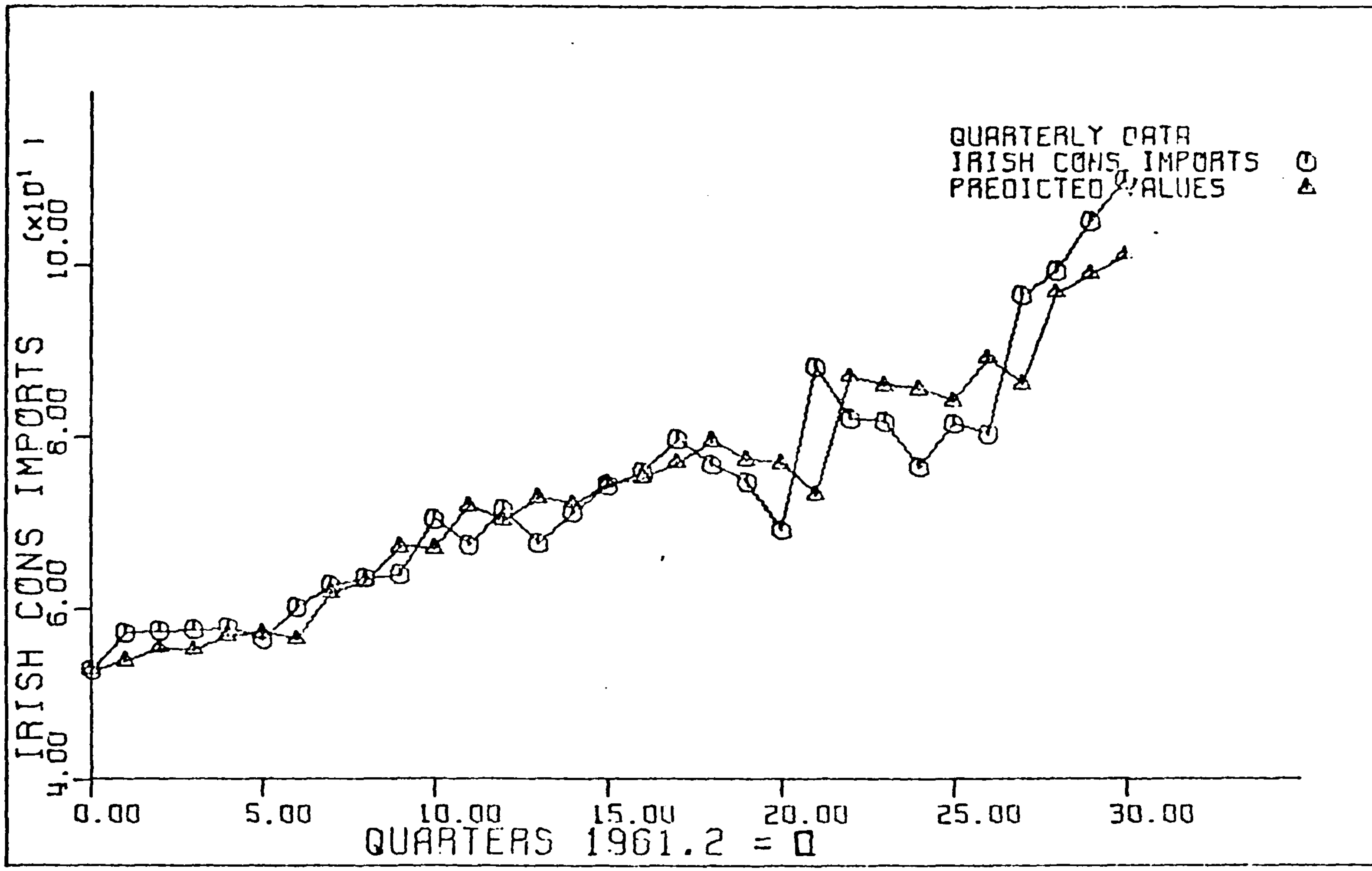

Figure B.3. Actual and predicted Irish consumer imports, 1961 II - 1968 IV £ million

Table B.4. Actual and predicted values for Irish imports of producers' durables 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	36.2	36.0	0.2	0.6
	III	33.3	38.3	-5.0	-15.0
	IV	35.8	35.9	-0.1	0.3
1962	I	36.0	37.1	-1.1	-3.1
	II	37.5	37.6	-0.1	-0.3
	III	39.1	38.8	0.3	0.8
	IV	44.2	39.9	4.3	9.7
1963	I	43.5	44.3	-0.8	-1.8
	II	41.6	43.8	-2.2	-5.3
	III	49.1	43.7	5.4	11.0
	IV	53.5	48.9	4.6	8.6
1964	I	51.0	52.8	-1.8	-3.5
	II	49.5	50.7	-1.2	-2.4
	III	52.8	50.0	2.8	5.3
	IV	50.8	52.6	-1.8	-3.5
1965	I	52.4	51.1	1.3	2.5
	II	58.5	52.1	6.4	10.9
	III	55.0	56.8	-1.8	-3.3
	IV	52.3	54.9	-2.6	-5.0
1966	I	48.5	52.5	-4.0	-8.3
	II	51.0	50.6	0.4	0.8
	III	56.0	51.4	4.6	8.2
	IV	54.9	56.4	-1.5	-2.7
1967	I	55.7	56.4	-0.7	-1.3
	II	49.2	57.2	-8.0	-16.3
	III	53.0	53.4	-0.4	-0.8
	V	51.0	56.7	-5.7	-11.2
1968	I	55.5	53.6	1.9	3.4
	II	61.1	58.3	2.8	4.6
	III	65.0	62.0	3.0	4.6
	IV	68.6	65.4	3.2	4.7

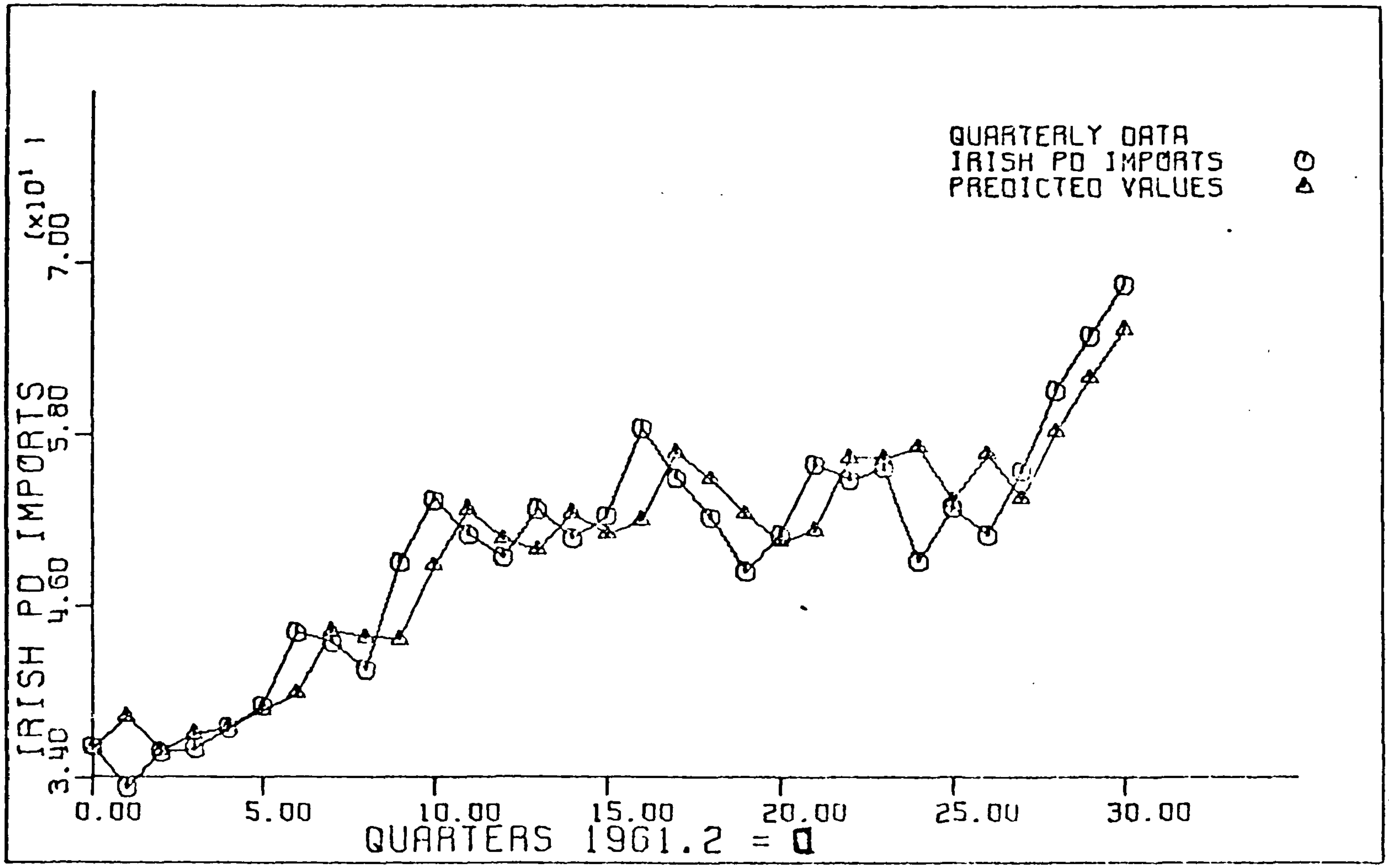

Figure B.4. Actual and predicted Irish producer durable imports, 1961 II - 1968 IV £ million

Table B.5. Actual and predicted values for Irish imports of producers' nondurables 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	140.0	141.7	-1.7	-1.2
	III	148.0	144.8	3.2	2.2
	IV	140.0	146.6	-6.6	-4.7
1962	I	137.7	142.4	-4.7	-3.4
	II	140.2	141.9	-1.7	-1.2
	III	148.2	144.2	4.0	2.7
	IV	150.0	149.6	0.4	0.3
1963	I	150.0	153.1	-3.1	-2.1
	II	150.0	152.4	-2.4	-1.6
	III	153.5	153.8	-0.3	-0.2
	IV	176.2	159.1	17.1	9.7
1964	I	176.0	176.4	-0.4	-0.2
	II	176.9	174.3	2.6	1.5
	III	175.2	178.1	-2.9	-1.7
	IV	177.4	175.0	2.4	1.4
1965	I	178.8	176.3	2.5	1.4
	II	172.6	179.0	-6.4	-3.7
	III	168.2	177.2	-9.0	-5.4
	IV	168.5	174.2	-5.7	-3.4
1966	I	164.2	171.8	-7.6	-4.6
	II	162.0	167.6	-5.6	-3.5
	III	173.0	164.7	8.3	4.8
	IV	176.6	174.9	1.7	1.0
1967	I	181.6	176.7	4.9	2.7
	II	181.6	180.6	1.0	0.6
	III	181.6	180.0	1.6	0.9
	IV	182.3	181.8	0.5	0.2
1968	I	205.2	194.0	11.2	5.5
	II	210.7	213.0	-2.3	-1.1
	III	213.0	219.0	-6.0	-2.8
	IV	229.8	222.6	7.2	3.1

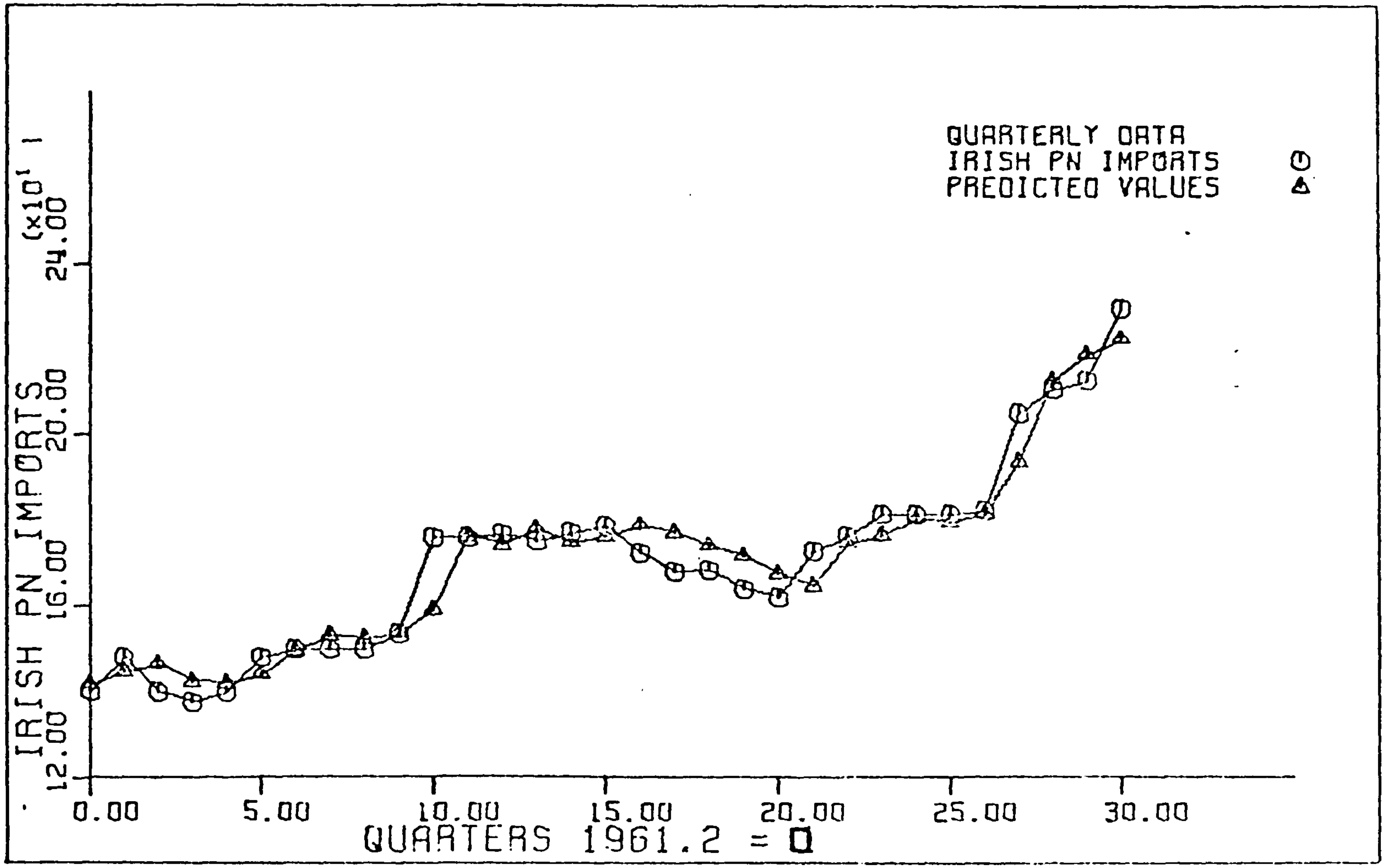

Figure B.5. Actual and predicted Irish producer nondurable imports, 1961 II - 1968 IV £ million

Table B.6. Actual and predicted values for Irish service imports 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	16.2	16.7	-0.5	-3.1
	III	16.7	18.0	-1.3	-7.8
	IV	17.6	18.1	-0.4	-2.3
1962	I	18.4	18.1	0.3	1.6
	II	19.1	18.6	0.5	2.6
	III	19.9	19.4	0.5	2.5
	IV	20.6	19.8	0.8	3.9
1963	I	21.3	21.1	0.2	0.9
	II	22.0	21.5	0.5	2.3
	III	22.8	23.0	-0.2	-0.9
	IV	23.6	23.4	0.2	0.9
1964	I	24.6	24.7	-0.1	-0.4
	II	25.6	24.9	0.7	2.7
	III	26.2	25.9	0.3	1.2
	IV	26.4	26.5	-0.1	-0.4
1965	I	26.6	26.5	0.1	0.4
	II	26.8	26.5	0.3	1.1
	III	27.4	27.1	0.3	1.1
	IV	28.4	27.9	0.5	1.8
1966	I	29.7	29.6	0.1	0.3
	II	30.9	31.0	-0.1	-0.3
	III	31.2	30.9	0.3	1.0
	IV	30.5	30.9	-0.4	-1.3
1967	I	29.5	31.1	-1.6	-5.4
	II	28.8	29.5	-0.7	-2.4
	III	29.1	29.7	-0.6	-2.1
	IV	30.3	30.5	-0.2	-0.7
1968	I	30.0	29.6	0.4	1.3
	II	32.8	30.9	1.9	5.8
	III	32.0	32.4	-0.4	-1.3
	IV	33.0	32.6	0.4	1.2

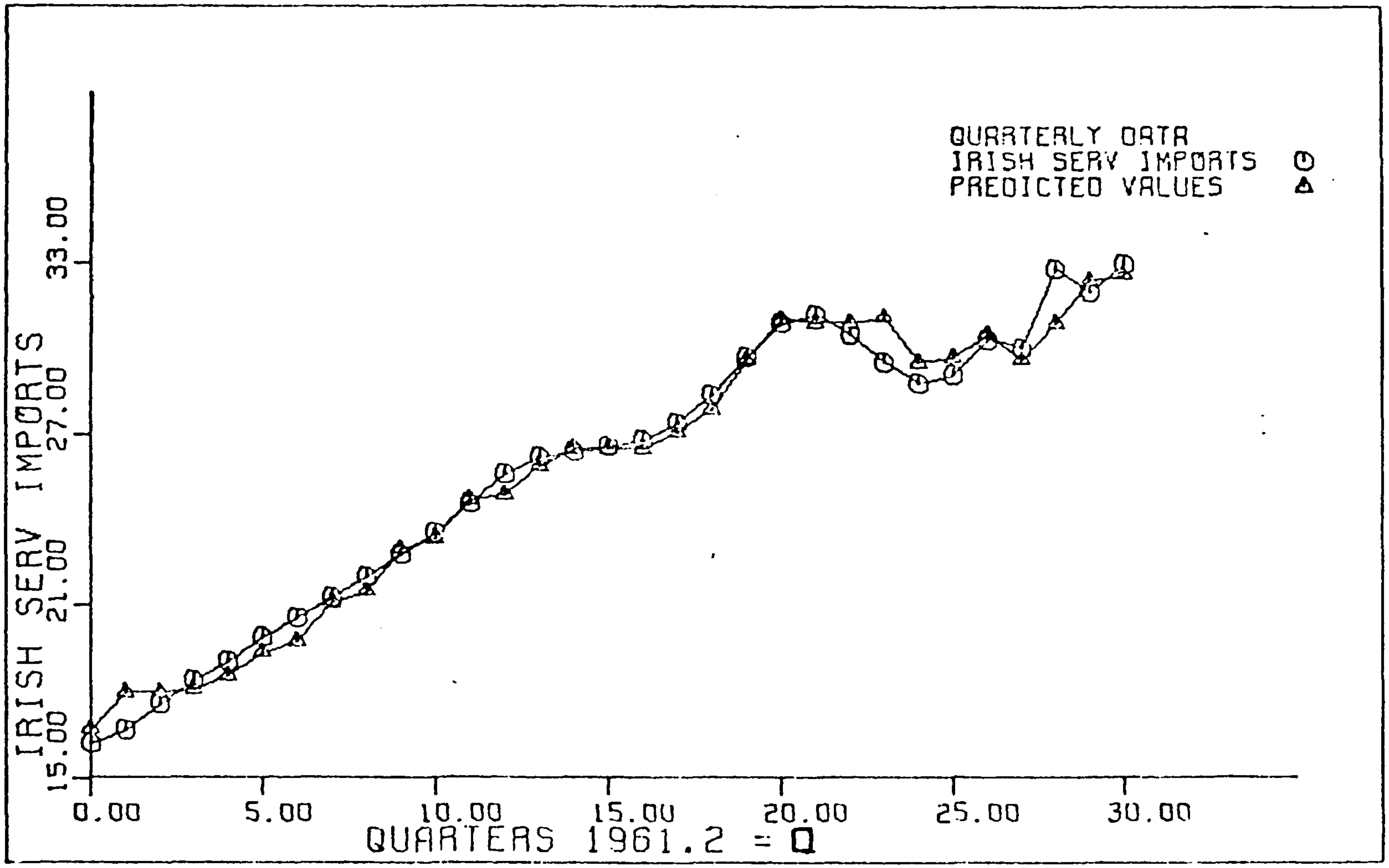

Figure B.6. Actual and predicted Irish service imports, 1961 II - 1968 IV £ million

Table B.7. Actual and predicted values for Irish consumer exports to the UK 1961 II - 1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	60.2	59.9	4.3	7.1
	III	52.9	57.6	-4.7	-8.9
	IV	53.1	53.9	-0.8	-1.5
1962	I	54.2	53.7	0.5	0.9
	II	53.2	55.0	-1.8	-3.4
	III	50.0	55.9	-5.9	-11.8
	IV	55.4	49.4	6.0	10.8
1963	I	55.1	53.8	1.3	2.4
	II	60.2	53.9	6.3	10.5
	III	58.9	61.0	-2.1	-3.6
	IV	60.2	62.2	-2.0	-3.3
1964	I	56.0	62.8	-6.8	-12.1
	II	61.4	61.9	-0.5	-0.8
	III	65.7	65.3	0.4	0.6
	IV	60.2	68.7	-8.5	-14.1
1965	I	56.0	61.4	-5.4	-9.6
	II	62.3	59.3	3.0	4.8
	III	65.0	62.3	2.7	4.2
	IV	68.0	65.5	2.5	3.8
1966	I	70.7	67.8	2.9	4.1
	II	60.6	71.0	-10.4	-17.2
	III	69.6	65.8	3.8	5.5
	IV	67.7	69.7	-2.0	-3.0
1967	I	76.0	73.1	2.9	3.8
	II	82.5	78.5	4.0	4.9
	III	88.2	84.3	3.9	4.4
	IV	92.3	89.1	3.2	3.5
1968	I	91.1	88.2	2.9	3.2
	II	84.1	89.9	-5.8	-6.9
	III	84.3	81.1	3.2	3.8
	IV	87.9	82.7	5.2	5.9

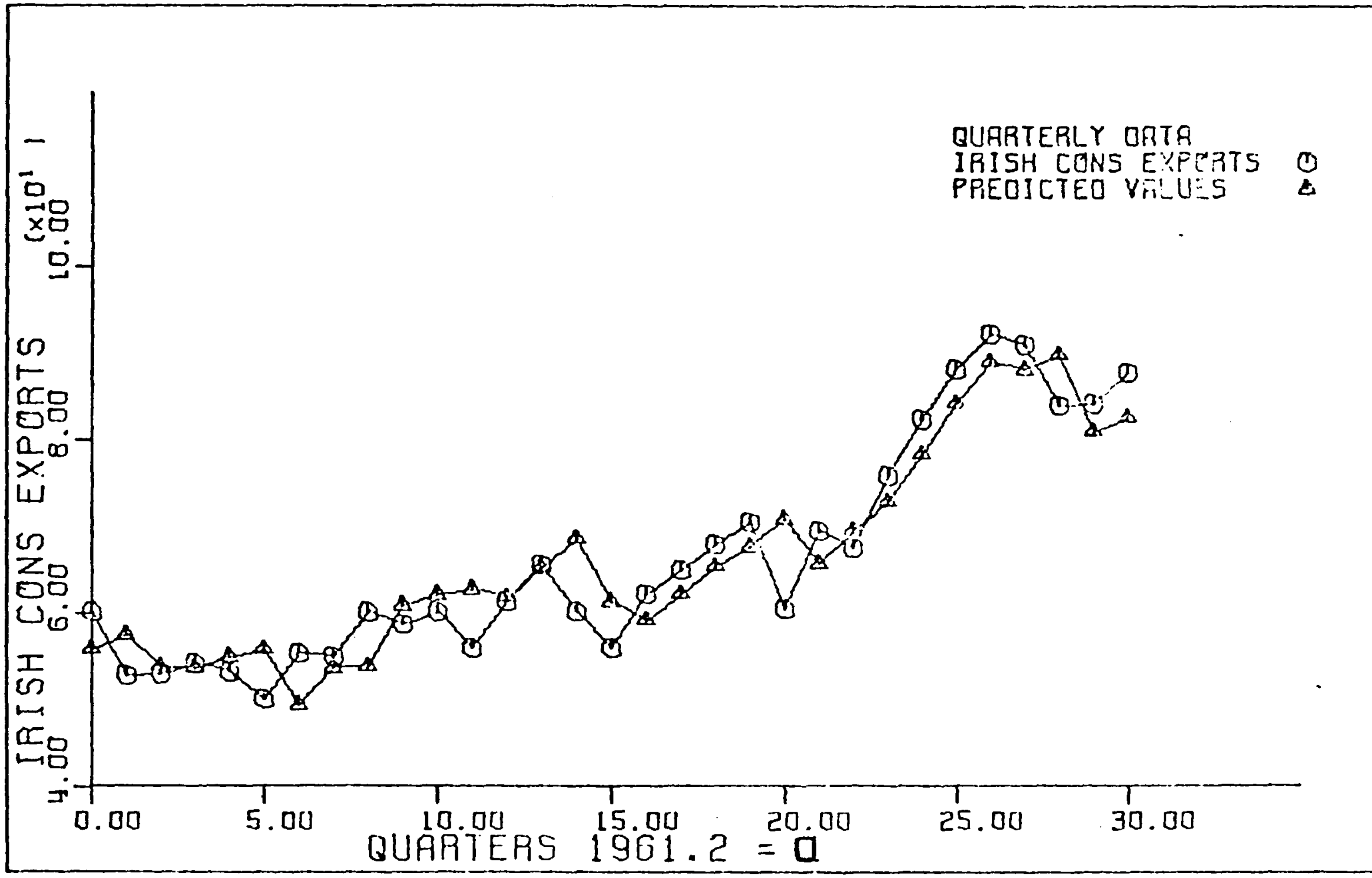

Figure B.7. Actual and predicted Irish consumer exports, 1961 II - 1968 IV £ million

Table B.8. Actual and predicted values of Irish producer nondurable exports to the UK 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	24.5	24.3	0.2	0.8
	III	23.0	24.0	-1.0	-4.3
	IV	23.0	22.6	0.4	1.7
1962	I	23.2	22.6	0.6	2.6
	II	23.2	22.8	0.4	1.7
	III	24.2	22.9	1.3	5.4
	IV	24.1	24.2	-0.1	-0.4
1963	I	24.0	24.2	-0.2	-0.8
	II	24.4	24.1	0.3	1.2
	III	25.0	24.9	0.1	0.4
	IV	28.7	25.6	3.1	10.5
1964	I	28.0	29.4	-1.4	-5.0
	II	29.3	29.0	0.3	1.0
	III	27.6	30.2	-2.6	-9.4
	IV	30.0	28.8	1.2	4.0
1965	I	31.0	31.2	-0.2	-0.6
	II	31.0	32.1	-1.1	-3.5
	III	31.5	32.4	-0.9	-2.9
	IV	31.8	33.0	-1.2	-3.8
1966	I	31.7	33.2	-1.5	-4.7
	II	31.5	33.2	-1.7	-5.4
	III	31.5	33.1	-1.6	-5.1
	IV	31.8	33.2	-1.4	-4.4
1967	I	32.0	33.4	-1.4	-4.4
	II	32.8	33.3	-0.5	-1.5
	III	34.0	34.1	-0.1	-0.3
	IV	40.2	35.0	5.2	12.9
1968	I	42.5	41.0	1.5	3.5
	II	43.2	43.3	-0.1	-0.2
	III	45.7	43.8	1.9	4.2
	IV	46.0	46.1	-0.1	-0.2

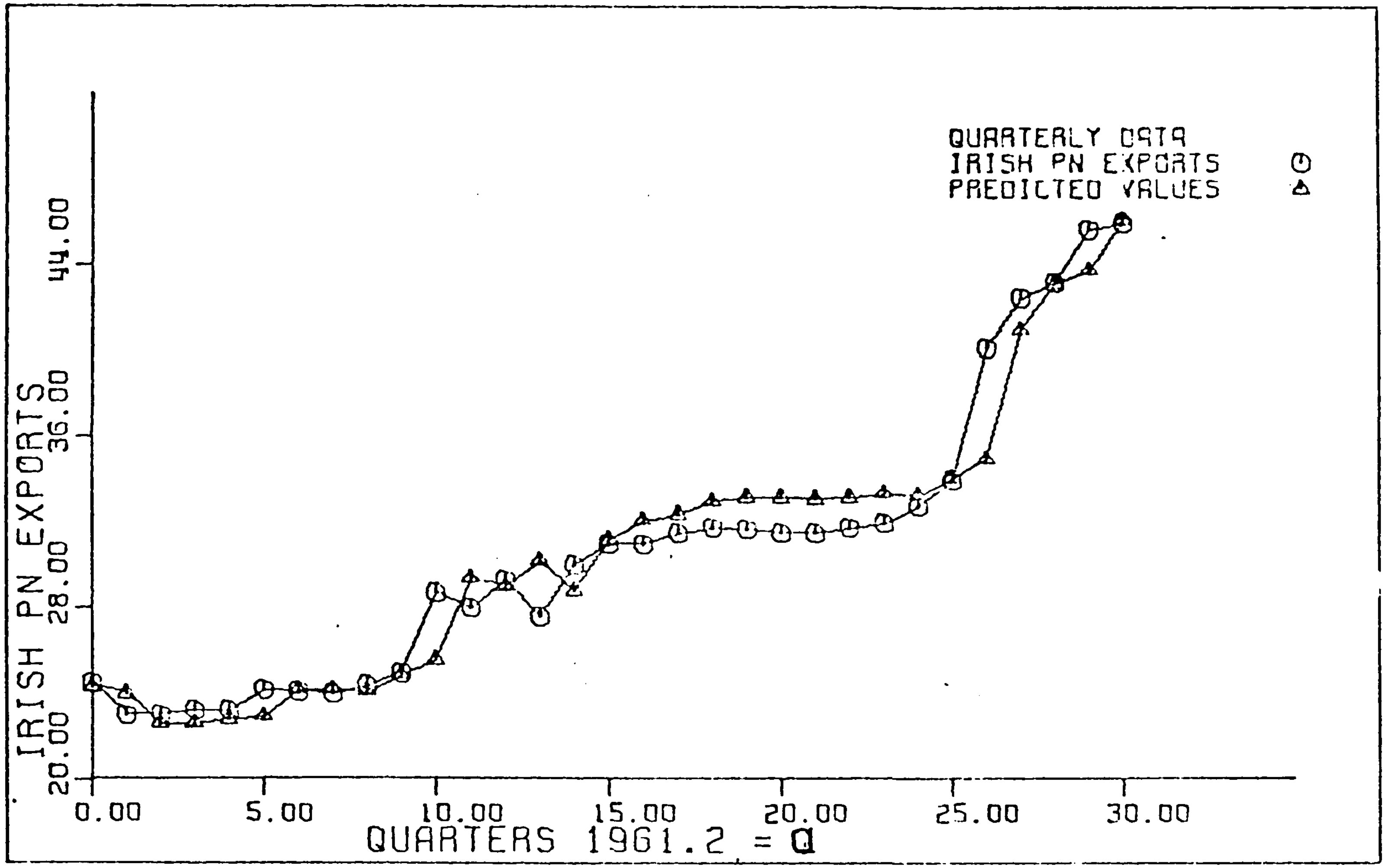

Figure B.8. Actual and predicted Irish producer nondurable exports, 1961 II - 1968 IV £ million

Table B.9. Actual and predicted values for Irish GNP 1961 II-1968 IV
£ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	746.0	737.5	8.2	1.1
	III	739.8	780.1	-40.6	-5.5
	IV	772.0	767.2	4.5	0.6
1962	I	767.0	751.8	14.9	1.9
	II	764.8	763.1	1.4	0.2
	III	760.4	767.0	-6.9	-0.9
	IV	794.3	766.8	27.2	3.4
1963	I	794.6	795.8	-1.9	-0.2
	II	818.5	796.3	19.0	2.3
	III	837.8	833.2	1.4	0.2
	IV	820.8	833.1	-15.5	-1.9
1964	I	843.3	863.0	-22.8	-2.7
	II	860.8	848.8	8.8	1.0
	III	848.1	860.9	-15.9	-1.9
	IV	866.9	871.7	-7.9	-0.9
1965	I	866.9	867.6	-3.8	-0.4
	II	879.5	863.6	12.8	1.5
	III	886.5	879.6	4.1	-0.5
	IV	894.6	894.1	-2.6	-0.3
1966	I	875.4	877.3	-2.1	-0.2
	II	894.8	899.4	-4.8	-0.5
	III	886.3	871.4	15.6	1.8
	IV	916.3	921.1	-4.0	-0.4
1967	I	933.5	943.0	-9.6	-1.0
	II	944.5	951.8	-7.4	-0.8
	III	973.6	971.2	2.4	0.2
	IV	987.6	992.0	-4.5	-0.5
1968	I	944.6	938.3	6.2	0.7
	II	1001.5	990.1	11.2	1.1
	III	983.5	984.0	-0.6	-0.1
	IV	1024.4	1006.3	18.0	1.8

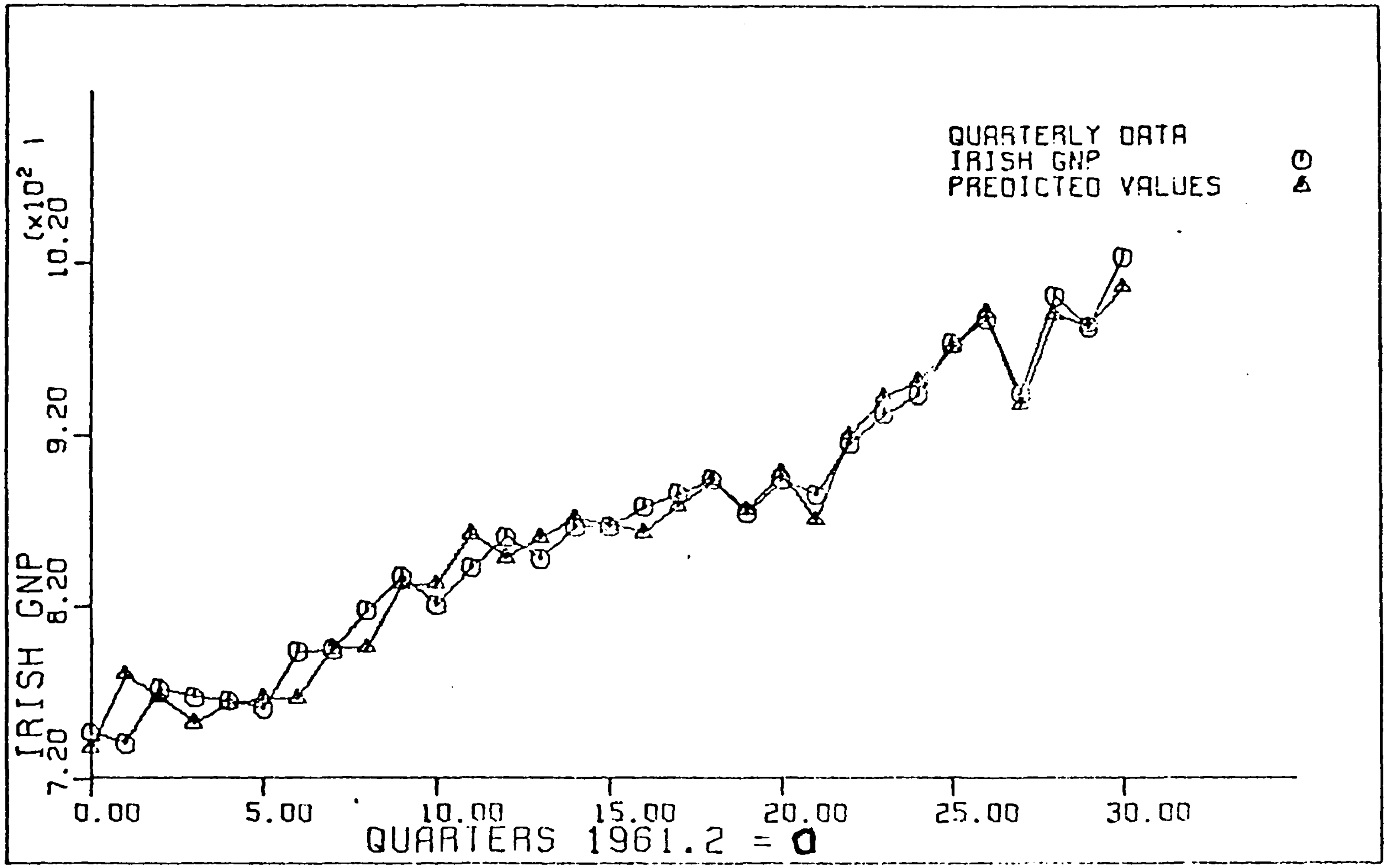

Figure B.9. Actual and predicted Irish GNP, 1961 II - 1968 IV £ million

Table B.10. Actual and predicted values for Irish taxes on expenditure 1961 II-1958 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	90.0	89.0	1.0	1.1
	III	96.2	91.5	4.7	4.9
	IV	89.5	91.4	-1.9	-2.1
1962	I	96.8	92.6	4.2	4.3
	II	89.7	96.6	-6.9	-7.7
	III	91.6	96.6	-5.0	-5.5
	IV	98.7	96.4	2.3	2.3
1963	I	95.6	106.4	-10.8	-11.3
	II	100.4	106.4	-6.0	-6.0
	III	100.3	114.5	-14.2	-14.2
	IV	103.4	114.0	-10.6	-10.3
1964	I	105.7	117.5	-11.8	-11.2
	II	112.6	118.0	-5.4	-4.8
	III	112.5	119.8	-7.3	-6.5
	IV	115.4	122.2	-6.8	-5.9
1965	I	116.6	125.2	-8.6	-7.4
	II	119.5	123.2	-3.7	-3.1
	III	114.8	125.1	-10.3	-9.0
	IV	120.4	126.7	-6.3	-5.2
1966	I	124.4	126.3	-1.9	-1.5
	II	128.4	124.9	3.5	2.7
	III	133.8	124.6	9.2	6.9
	IV	130.9	136.9	-6.0	-4.6
1967	I	140.1	140.1	0	0
	II	140.9	138.5	2.4	1.7
	III	142.3	139.0	3.3	2.3
	IV	142.6	147.0	-4.4	-3.1
1968	I	143.5	144.0	-0.5	-0.4
	II	150.0	149.8	0.2	0.1
	III	152.5	155.4	-2.9	-1.9
	IV	156.8	151.3	5.5	-3.5

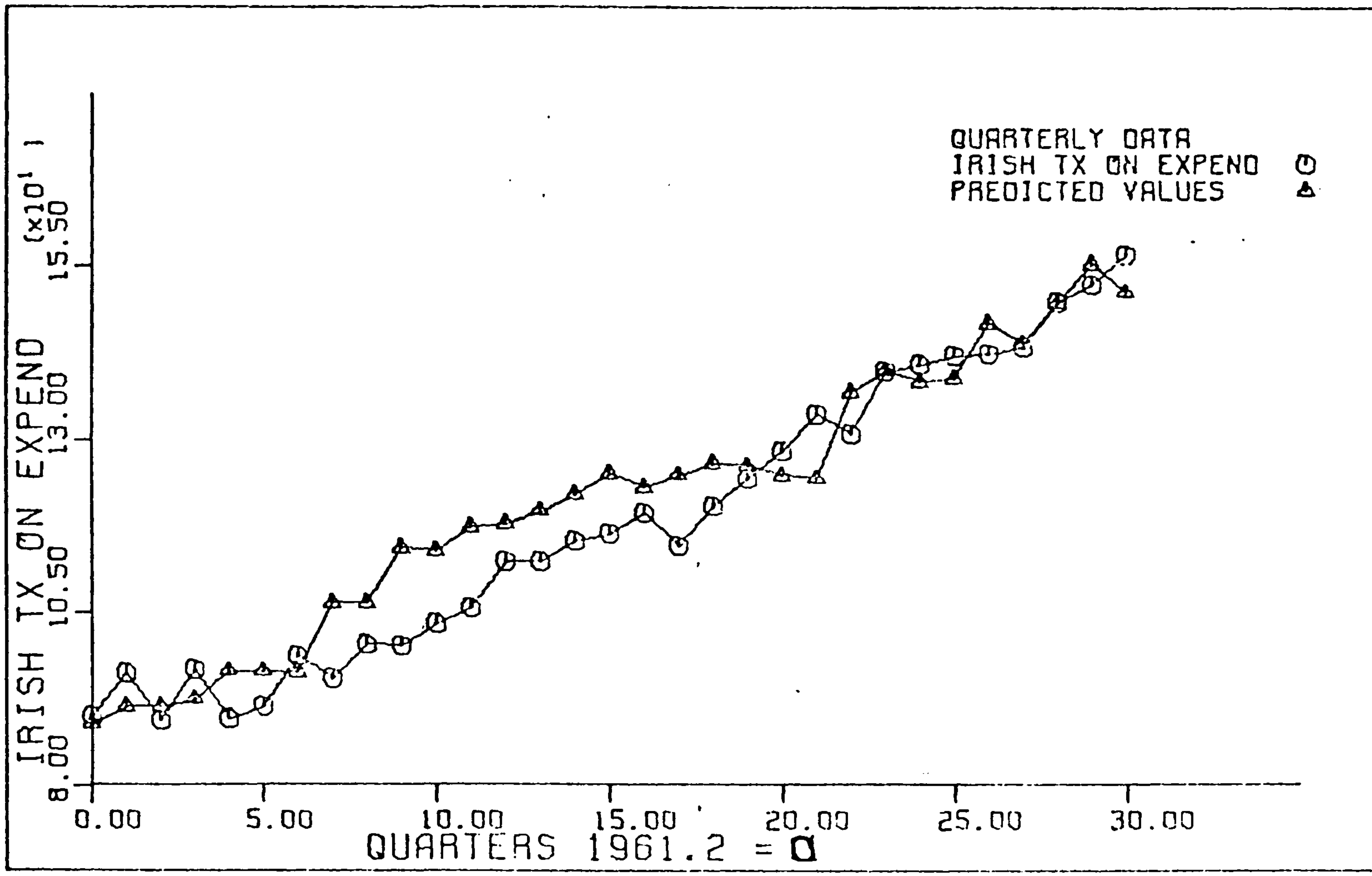

Figure B.10. Actual and predicted Irish taxes on expenditure, 1961 II - 1968 IV £ million

Table B.11. Actual and predicted values for Irish taxes on income 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	44.8	44.0	0.8	1.8
	III	45.4	50.8	-5.4	-11.9
	IV	49.1	47.4	1.7	3.5
1962	I	48.9	50.1	-1.2	-2.5
	II	49.2	49.5	-0.2	-0.4
	III	51.5	50.7	0.8	1.6
	IV	52.0	49.9	2.1	4.0
1963	I	55.3	57.1	-1.8	-3.3
	II	55.4	51.4	4.0	7.2
	III	56.5	58.0	-1.5	-2.7
	IV	59.8	60.6	-0.8	-1.3
1964	I	61.6	61.8	-0.2	-0.3
	II	63.7	62.3	1.4	2.2
	III	64.5	65.2	-0.7	-1.1
	IV	66.3	64.7	1.6	2.4
1965	I	64.8	65.8	-1.0	-1.5
	II	66.7	65.3	1.4	-2.1
	III	67.4	68.6	-1.2	-1.8
	IV	73.0	72.1	0.9	1.2
1966	I	74.6	75.3	-0.7	-0.9
	II	74.9	75.6	-0.7	-0.9
	III	80.0	73.6	6.4	8.0
	IV	80.1	77.2	2.9	3.6
1967	I	81.1	84.2	-3.1	-3.8
	II	88.3	86.7	1.6	1.8
	III	85.3	84.2	1.1	1.3
	IV	86.6	89.7	-3.1	-3.6
1968	I	86.9	84.2	2.7	3.1
	II	86.8	85.1	1.7	2.0
	III	93.2	96.5	-3.3	-3.5
	IV	99.2	97.6	1.6	1.6

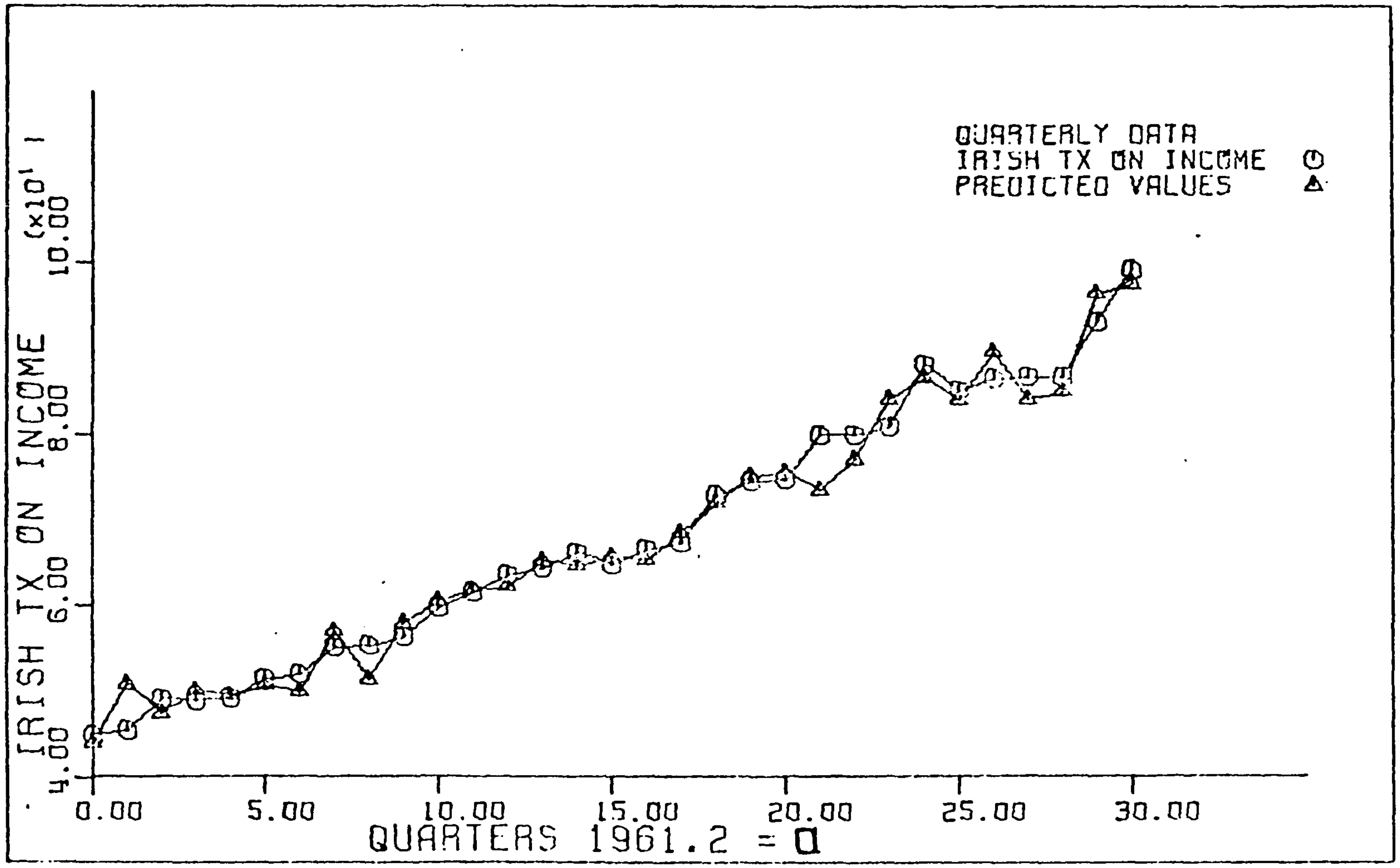

Figure B.11. Actual and predicted Irish taxes on income, 1961 II - 1968 IV £ million

Table B.12. Actual and predicted values of Irish depreciation 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	46.9	56.8	-9.9	-21.1
	III	48.1	57.5	-9.4	-19.5
	IV	49.7	58.0	-8.3	-16.7
1962	I	51.2	58.6	-7.4	-14.5
	II	52.6	59.3	-6.7	-12.7
	III	54.0	59.9	-5.9	-10.9
	IV	55.5	56.7	-1.2	-2.2
1963	I	57.2	57.4	-0.2	-0.3
	II	58.9	58.1	-0.2	1.3
	III	60.0	58.8	1.2	2.0
	IV	60.3	59.6	0.7	1.2
1964	I	60.4	60.6	-0.2	-0.3
	II	60.9	61.5	-0.6	-1.0
	III	61.7	62.5	-0.8	-1.3
	IV	63.0	63.4	-0.4	-0.6
1965	I	64.4	64.4	0.0	0
	II	65.6	65.4	0.2	0.3
	III	66.6	66.5	0.1	0.2
	IV	67.5	61.6	5.9	8.7
1966	I	68.4	68.6	-0.2	-0.3
	II	69.5	69.5	0.0	0
	III	70.2	70.3	-0.1	-0.1
	IV	70.7	71.3	-0.6	-0.8
1967	I	71.0	70.7	0.3	0.4
	II	71.5	71.6	-0.1	-0.1
	III	72.2	72.4	-0.2	-0.3
	IV	73.2	73.3	-0.1	-0.1
1968	I	74.2	74.1	0.1	0.1
	II	75.1	75.1	0	0
	III	75.9	76.3	-0.4	-0.5
	IV	76.8	77.5	-0.7	-0.9

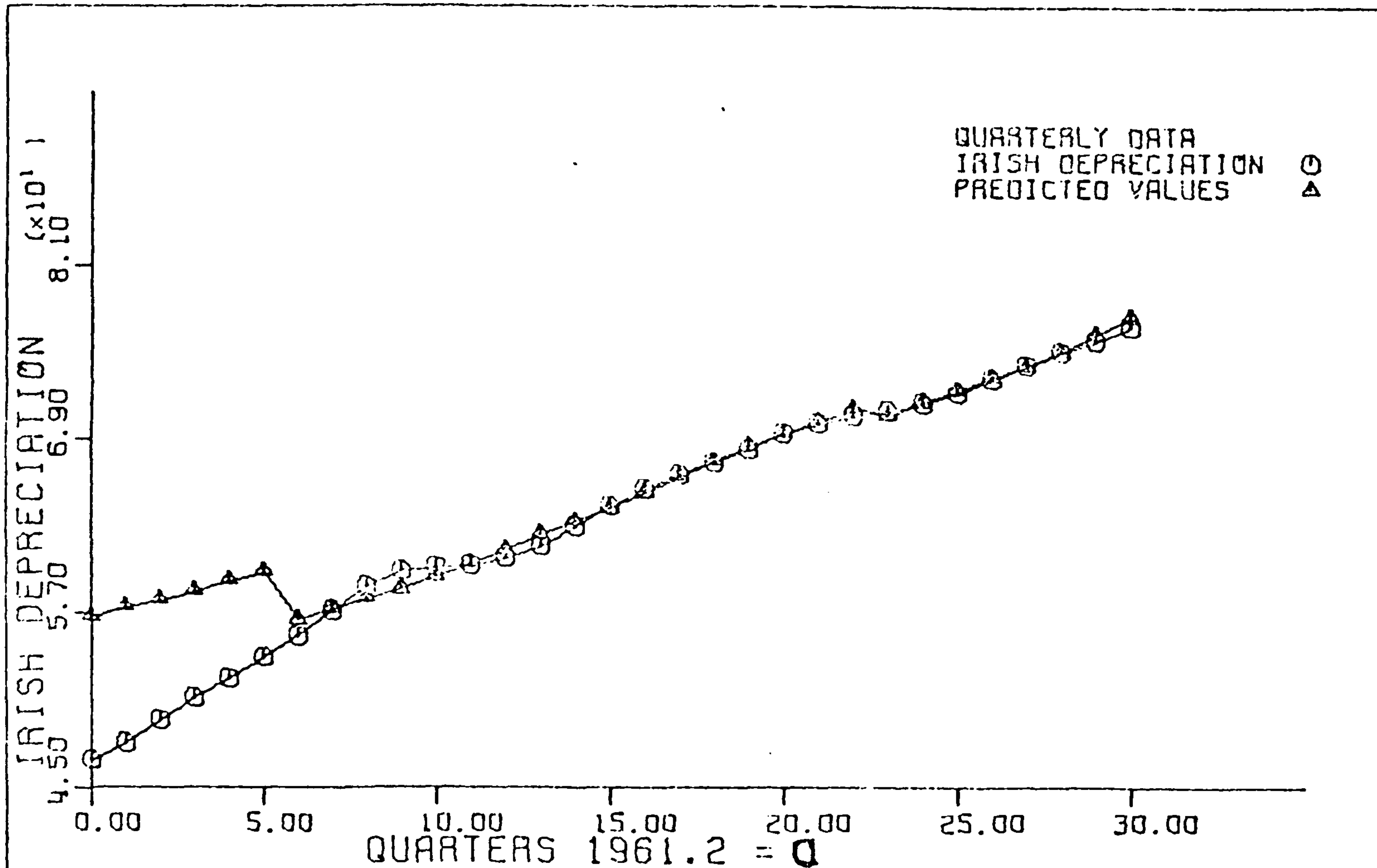

Figure B.12. Actual and predicted Irish depreciation, 1961 II - 1968 IV £ million

Table B.13. Actual and predicted values of UK consumption 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	18,820	19,002	-182	-1.0
	III	18,928	18,999	-71	0.4
	IV	18,908	19,094	-186	-1.0
1962	I	19,032	19,032	0	0
	II	19,304	19,152	152	0.8
	III	19,276	19,380	-104	-0.5
	IV	19,464	19,397	67	0.3
1963	I	19,536	19,593	-57	-0.3
	II	20,072	19,636	436	2.2
	III	20,376	20,296	80	0.4
	IV	20,364	20,612	-248	-1.2
1964	I	20,628	20,588	40	-0.2
	II	20,676	20,840	-164	-0.8
	III	20,804	20,884	-80	-0.4
	IV	21,024	21,012	12	0.1
1965	I	21,108	21,266	-158	-0.7
	II	20,984	21,322	-338	-1.6
	III	21,268	21,206	62	0.3
	IV	21,372	21,472	-100	-0.5
1966	I	21,676	21,553	123	0.6
	II	21,844	21,803	41	0.2
	III	21,540	21,926	-386	-1.8
	IV	21,416	21,709	-294	-1.4
1967	I	21,604	21,538	66	0.3
	II	21,940	21,616	324	1.5
	III	22,288	21,933	355	1.6
	IV	22,464	22,162	302	1.3
1968	I	83,032	22,534	498	2.2
	II	22,172	22,931	-759	-3.4
	III	22,460	22,181	279	1.2
	IV	22,616	22,413	203	0.9

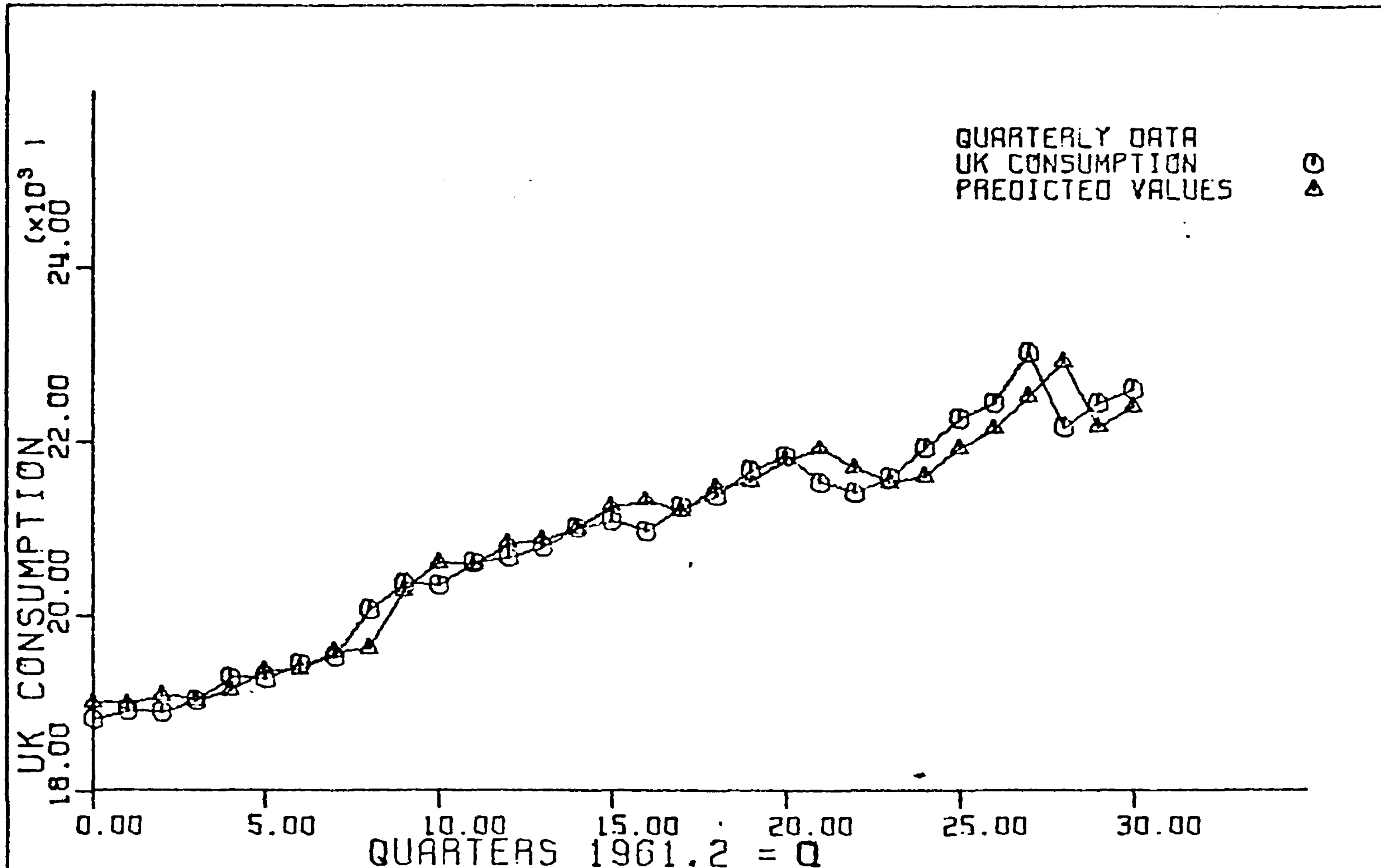

Figure B.13. Actual and predicted UK consumption, 1961 II - 1968 IV £ million

Table B.14. Actual and predicted values of UK investment 1961 II-1968 IV
£ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	5232	5083	149	2.8
	III	5108	5025	83	1.6
	IV	5028	4985	43	0.9
1962	I	4808	4817	-9	-0.2
	II	4936	4776	160	3.2
	III	5108	4803	305	6.0
	IV	4748	4959	-211	-4.4
1963	I	4284	5008	-724	-16.9
	II	5136	4759	377	7.3
	III	5204	5568	-364	-7.0
	IV	5896	5889	7	0.1
1964	I	6032	6038	4	0.1
	II	6360	6231	129	2.0
	III	6400	6315	85	1.3
	IV	6648	6397	251	3.8
1965	I	6324	6774	-450	-7.1
	II	6216	6545	-329	-5.3
	III	6308	6433	-125	-2.0
	IV	6488	6629	-141	-2.2
1966	I	6344	6642	-298	-4.7
	II	6316	6583	-267	-4.7
	III	6520	6641	-121	-1.8
	IV	6550	6601	-51	-0.8
1967	I	6592	6602	-10	-0.2
	II	6892	6273	619	9.0
	III	6800	6523	277	4.1
	IV	6720	6233	487	7.2
1968	I	6340	7168	-828	-13.1
	II	6992	6843	149	2.1
	III	7124	6921	203	2.8
	IV	7600	6956	644	8.5

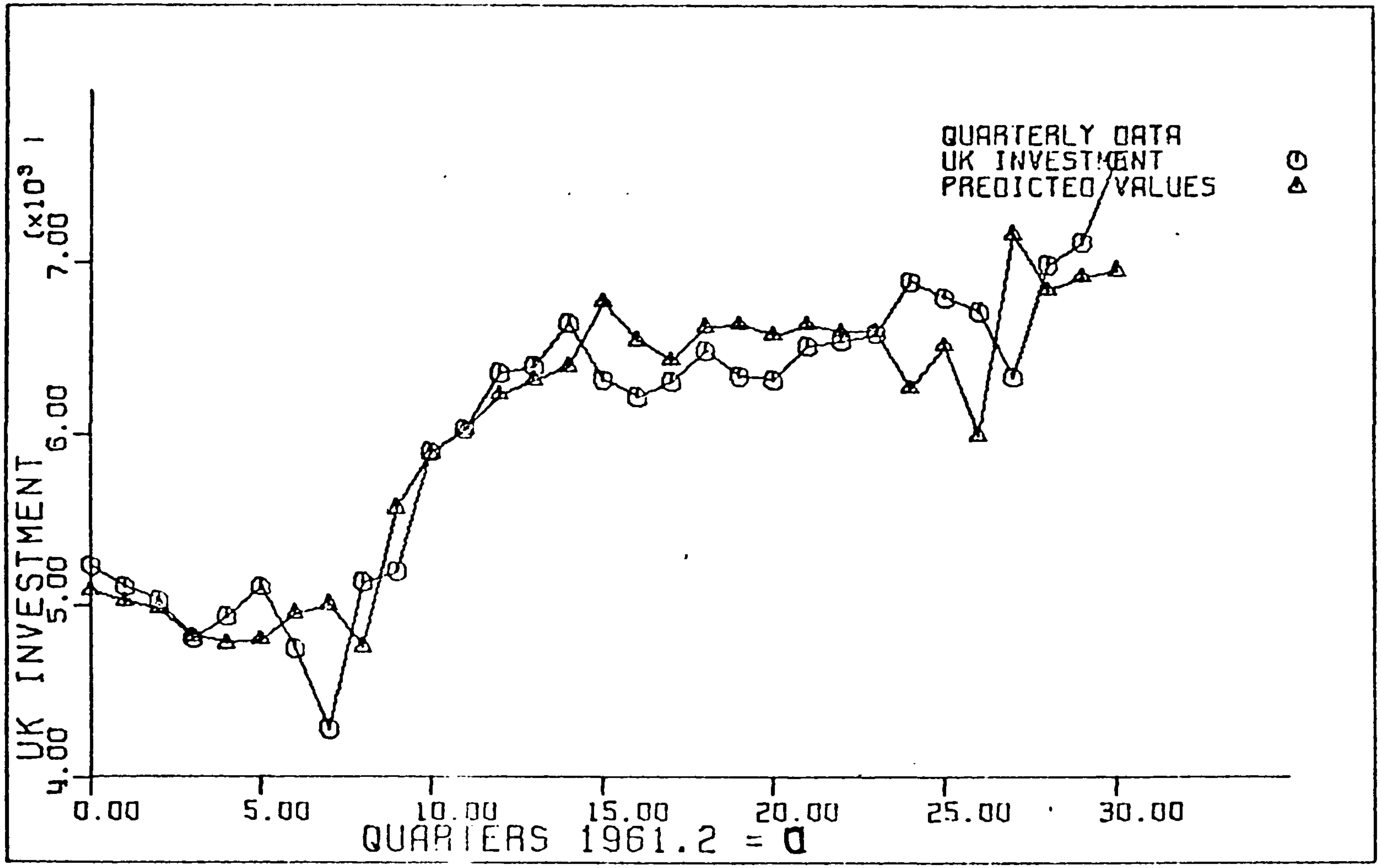

Figure B.14. Actual and predicted UK investment, 1961 II - 1968 IV £ million

Table B.15. Actual and predicted values of UK consumer imports 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	1810	1837	-27	-1.5
	III	1830	1837	-7	-0.4
	IV	1825	1848	-23	-1.3
1962	I	1850	1841	9	0.5
	II	1890	1854	36	1.9
	III	1850	1879	-29	-1.6
	IV	1800	1797	3	0.2
1963	I	1810	1819	-9	-0.5
	II	1851	1824	27	1.5
	III	1932	1897	35	1.8
	IV	1919	1932	-13	-0.7
1964	I	1938	1929	9	0.5
	II	1944	1957	-13	-0.7
	III	1947	1962	-15	-0.8
	IV	1960	1976	-16	-0.8
1965	I	1863	1905	-42	-2.3
	II	1901	1911	-10	-0.5
	III	1932	1898	34	1.8
	IV	1952	1928	24	1.2
1966	I	1968	1937	31	1.6
	II	1935	1964	-29	-1.5
	III	1900	1978	-78	-3.9
	IV	1911	1954	-43	-2.2
1967	I	2031	2034	-3	-0.1
	II	2083	2043	40	1.9
	III	2131	2078	53	2.5
	IV	2139	2104	35	1.6
1968	I	2099	2044	55	2.6
	II	2004	2088	-84	-4.2
	III	2028	2005	23	1.1
	IV	2063	2031	32	1.6

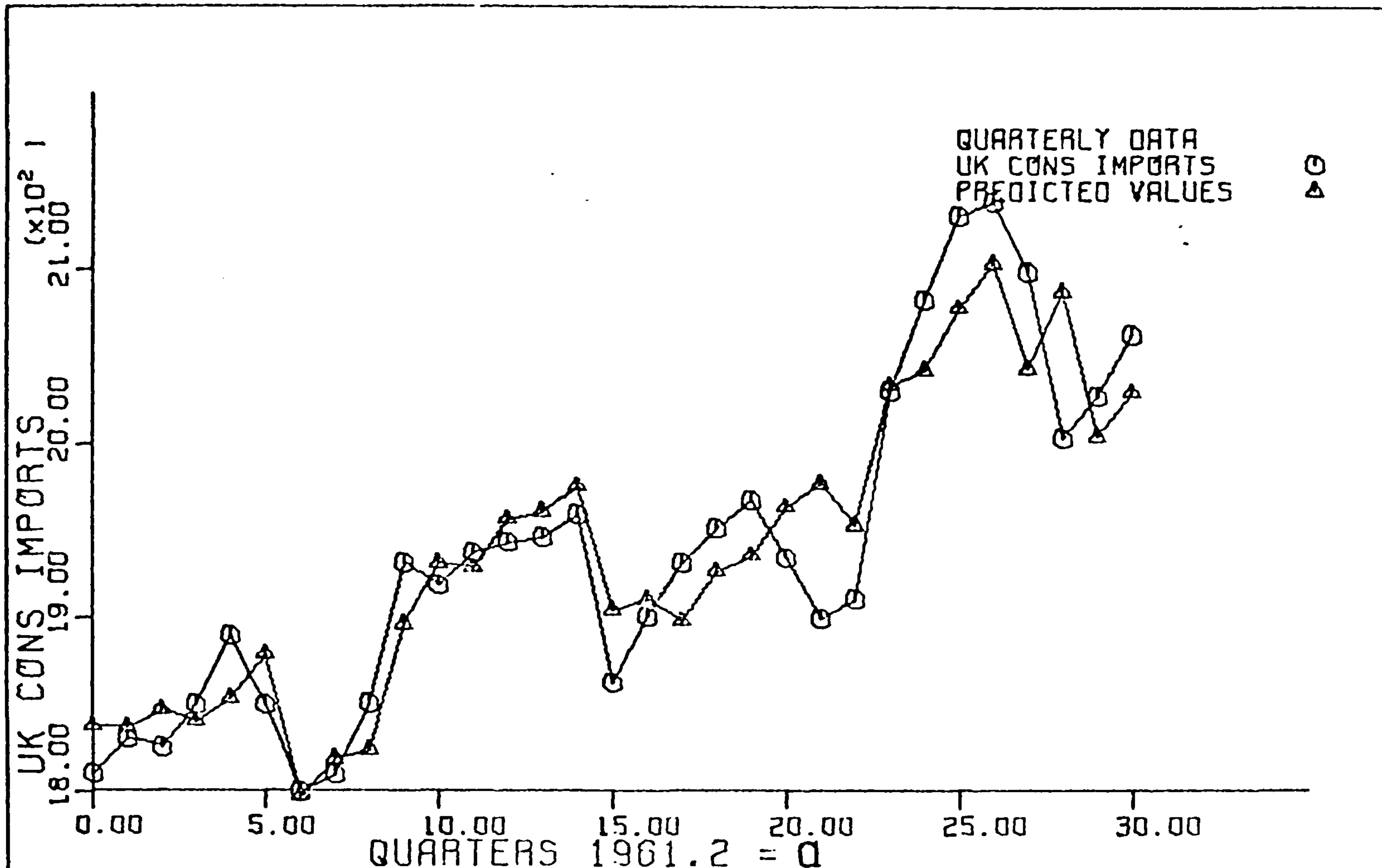

Figure B.15. Actual and predicted UK consumer imports, 1961 II - 1968 IV £ million

Table B.16. Actual and predicted values of UK imports of producer durables 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	388	332	56	14.4
	III	412	342	70	16.8
	IV	408	356	52	12.7
1962	I	400	395	5	1.3
	II	414	402	12	2.9
	III	401	411	-10	-2.5
	IV	402	430	-28	-7.0
1963	I	394	457	-63	-16.0
	II	411	329	82	20.0
	III	415	417	-2	-0.5
	IV	445	467	-22	-4.9
1964	I	496	475	21	4.2
	II	525	521	4	0.8
	III	544	538	6	1.1
	IV	563	563	0	0
1965	I	556	621	-65	-11.7
	II	555	610	-55	-9.9
	III	610	607	3	0.5
	IV	649	656	-7	1.1
1966	I	661	672	-11	-1.7
	II	665	682	-17	-2.6
	III	667	702	-35	-4.9
	IV	670	716	-46	-6.4
1967	I	719	707	12	1.7
	II	748	683	65	8.7
	III	837	840	-3	-0.4
	IV	830	840	-10	-1.2
1968	I	896	980	-84	-9.4
	II	890	979	-89	-10.0
	III	996	971	25	2.5
	IV	1090	1012	78	7.2

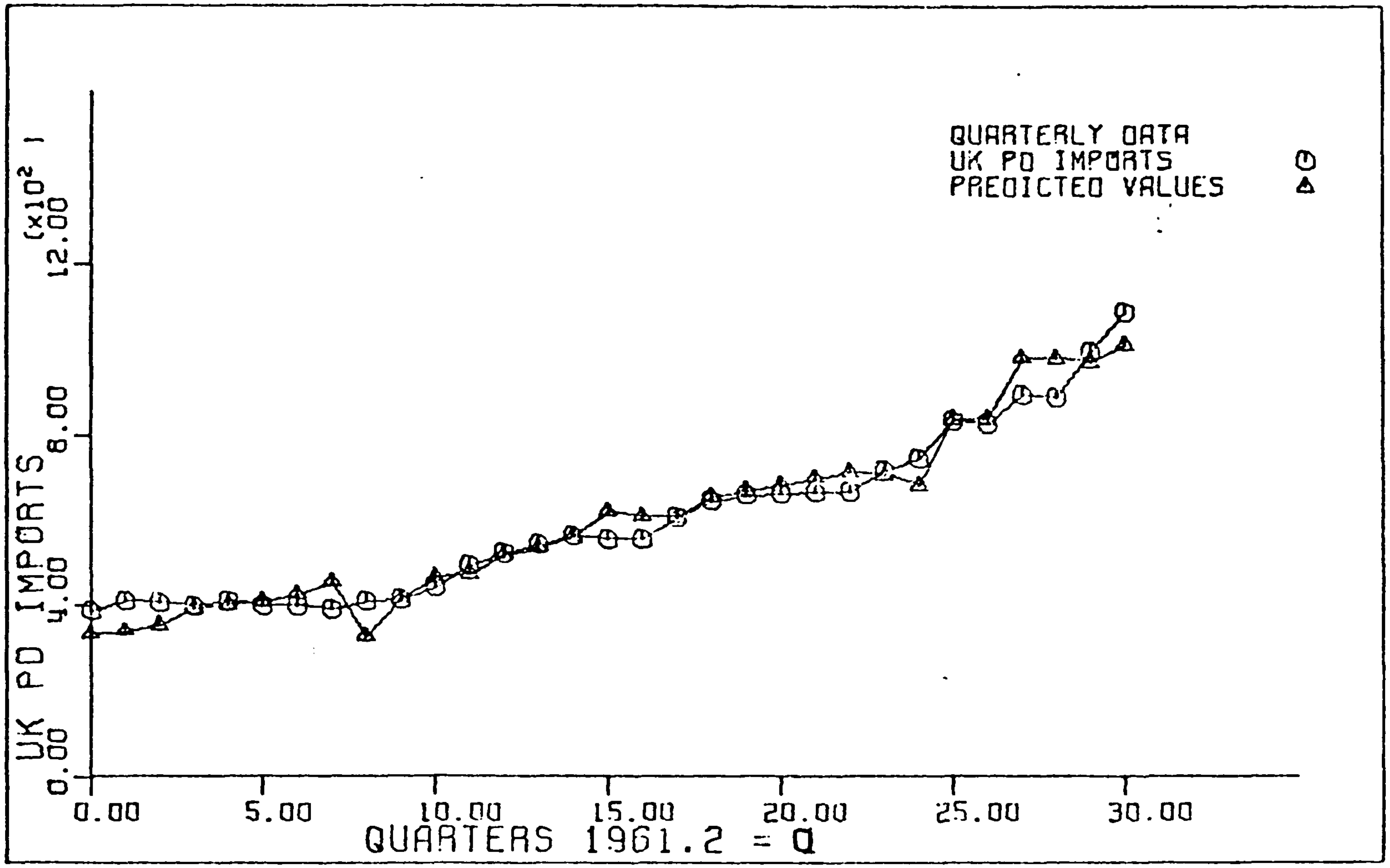

Figure B.16. Actual and predicted UK producer durable imports, 1961 II - 1968 IV £ million

Table B.17. Actual and predicted values of UK imports of producer nondurables 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	2288	2362	-74	-3.2
	III	2206	2278	-72	-3.3
	IV	2199	2245	-46	-2.1
1962	I	2231	2225	6	0.3
	II	2240	2254	-14	-0.6
	III	2402	2265	137	5.7
	IV	2394	2376	18	0.8
1963	I	2393	2407	-14	-0.6
	II	2393	2394	-1	0
	III	2375	2502	-127	-5.3
	IV	2756	2557	199	7.2
1964	I	2735	2748	-13	-0.5
	II	2816	2780	36	1.3
	III	2746	2828	-82	-3.0
	IV	2834	2819	15	0.5
1965	I	2906	2931	-25	-0.9
	II	3020	2956	64	2.1
	III	3020	3011	9	0.3
	IV	3020	3054	-34	-1.1
1966	I	3020	3059	-39	-1.3
	II	3020	3068	-48	-1.6
	III	3020	3092	-72	-2.3
	IV	3020	3109	-87	-2.9
1967	I	3020	3096	-76	-2.5
	II	3020	3050	-30	-1.0
	III	3047	3089	-42	-1.4
	IV	3200	3068	132	4.1
1968	I	3439	3330	109	3.2
	II	3450	3424	26	0.8
	III	3551	3421	130	3.7
	IV	3468	3485	-17	-0.5

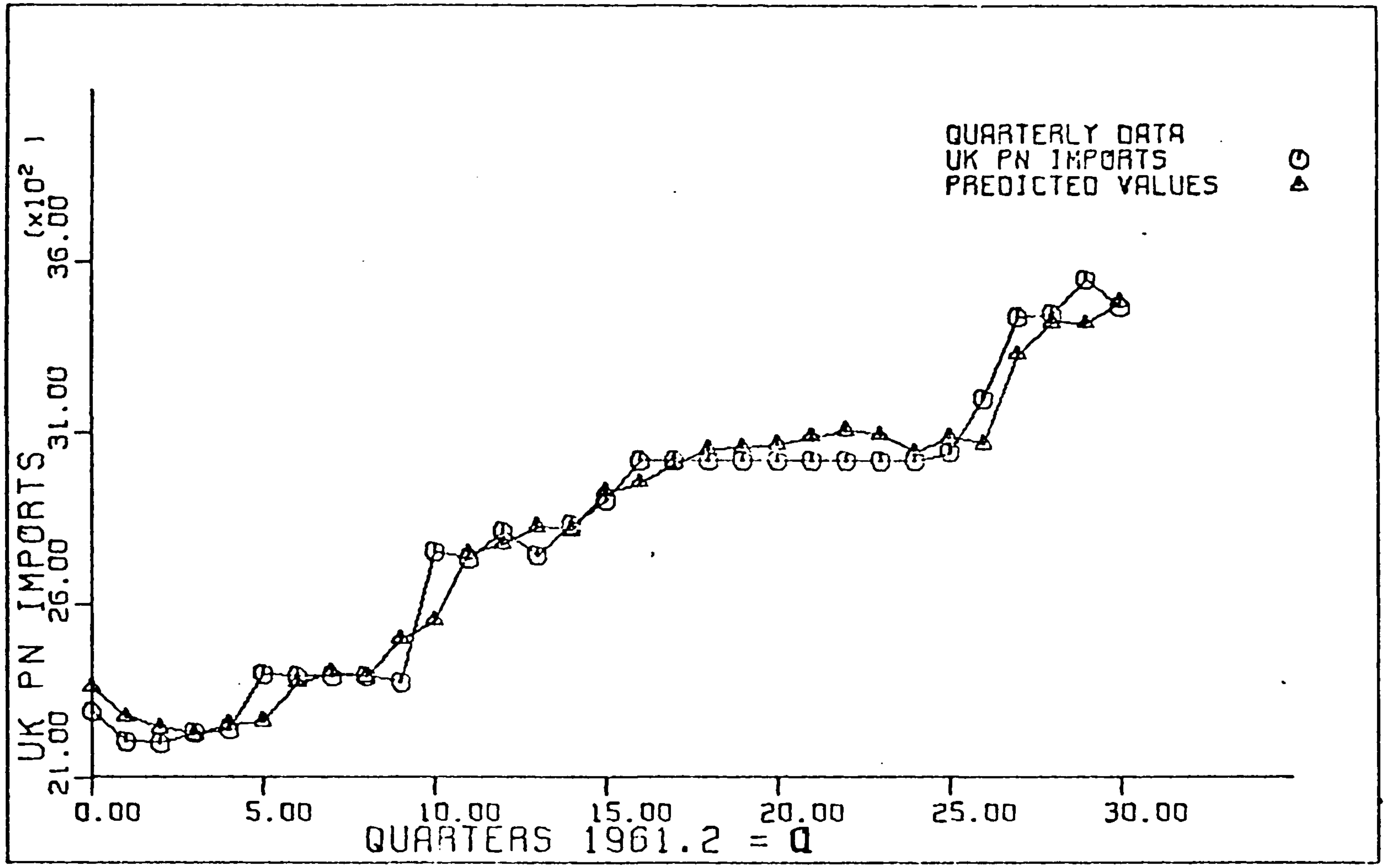

Figure B.17. Actual and predicted UK producer nondurable imports, 1961 II - 1968 IV £ million

Table B.18. Actual and predicted values of UK service imports 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	1487	15.4	-27	-1.8
	III	1478	1510	-32	-2.2
	IV	1496	1509	-13	-0.9
1962	I	1576	1512	64	4.1
	II	1562	1549	13	0.8
	III	1504	1545	-41	-2.7
	IV	1548	1529	19	1.2
1963	I	1548	1558	-10	-0.6
	II	1581	1554	27	1.7
	III	1598	1600	-2	-0.1
	IV	1609	1625	-16	-1.0
1964	I	1653	1630	23	1.4
	II	1660	1660	0	0
	III	1651	1666	-15	-0.9
	IV	1650	1670	-20	-1.2
1965	I	1665	1689	-24	-1.4
	II	1704	1692	12	0.7
	III	1739	1707	32	1.8
	IV	1728	1735	-7	-0.4
1966	I	1693	1731	-38	-2.2
	II	1719	1720	-1	-0.1
	III	1750	1738	12	0.7
	IV	1744	1756	-12	-0.7
1967	I	1711	1749	-38	-2.2
	II	1762	1721	41	2.3
	III	1798	1754	44	2.4
	IV	1826	1759	67	3.7
1968	I	1819	1826	-7	-0.4
	II	1764	1815	-51	-2.9
	III	1757	1789	-32	-1.8
	IV	1845	1790	55	3.0

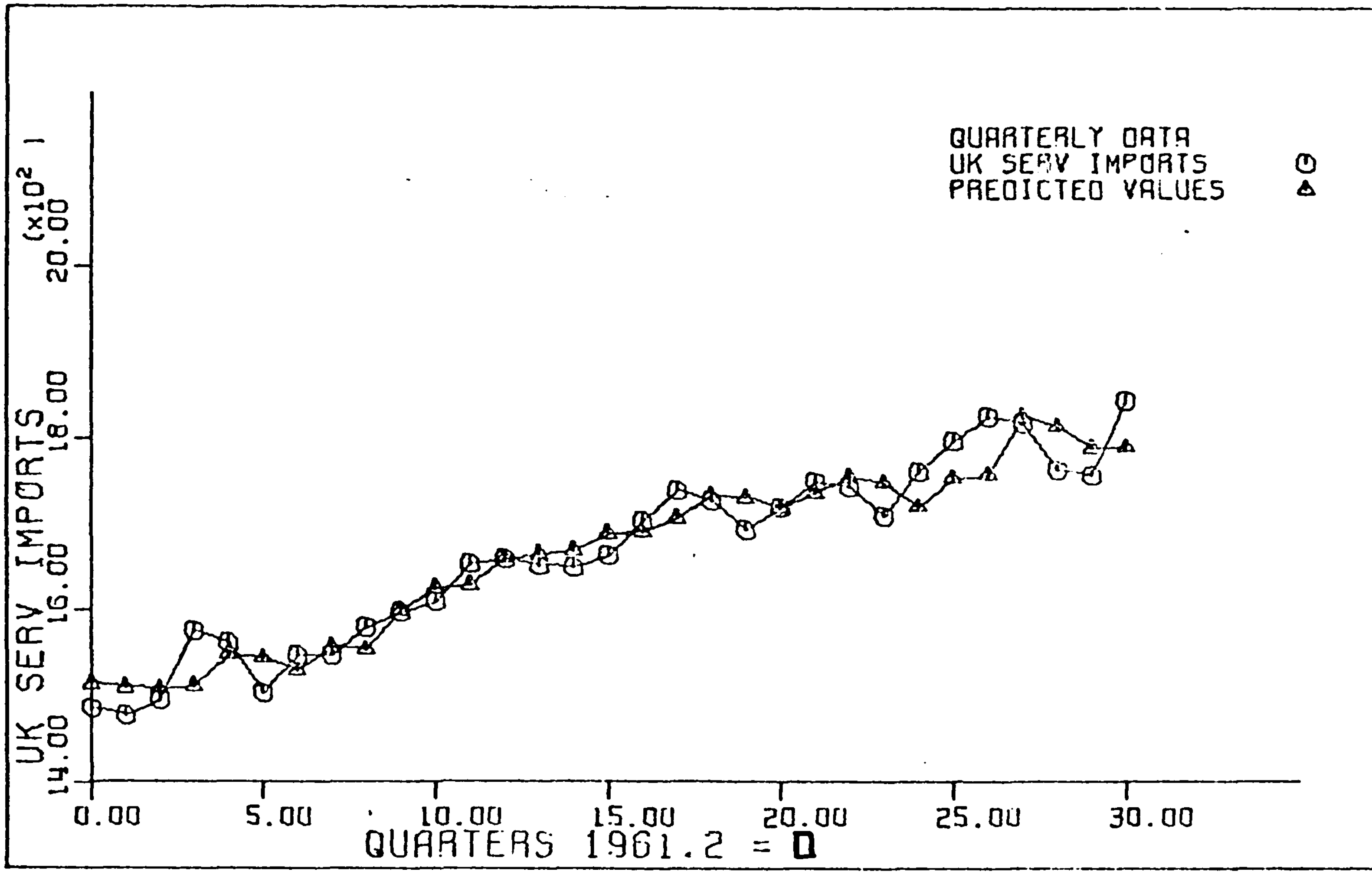

Figure B.18. Actual and predicted UK service imports, 1961 II - 1968 IV £ million

Table B.19. Actual and predicted values of UK GNP 1961 II-1968 IV
£ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	28579	28537	42	0.1
	III	28655	28601	54	0.2
	IV	28579	28694	-115	-0.4
1962	I	28427	28521	-94	-0.3
	II	28919	28655	264	0.9
	III	28865	28722	143	0.5
	IV	28863	29019	-156	-0.5
1963	I	23700	29384	-684	-2.4
	II	29926	29249	677	-2.3
	III	30179	30366	-187	-0.6
	IV	30628	31018	-390	-1.3
1964	I	31008	31004	4	0
	II	31363	31424	-61	-0.2
	III	31637	31527	110	0.3
	IV	32069	31786	283	0.9
1965	I	32031	32484	-453	-1.4
	II	31688	32367	-679	-2.1
	III	32199	32340	-141	-0.4
	IV	32558	32775	-217	-0.7
1966	I	32707	32826	-119	-0.4
	II	32789	32921	-132	-0.4
	III	32830	33166	-336	-1.0
	IV	33058	33343	-285	-0.9
1967	I	33374	33213	161	0.5
	II	33528	32704	824	2.5
	III	33713	33134	579	1.7
	IV	33339	32777	562	1.7
1968	I	34281	34684	-403	-1.2
	II	33994	34407	-413	-1.2
	III	34654	34319	335	1.0
	IV	35145	34447	698	2.0

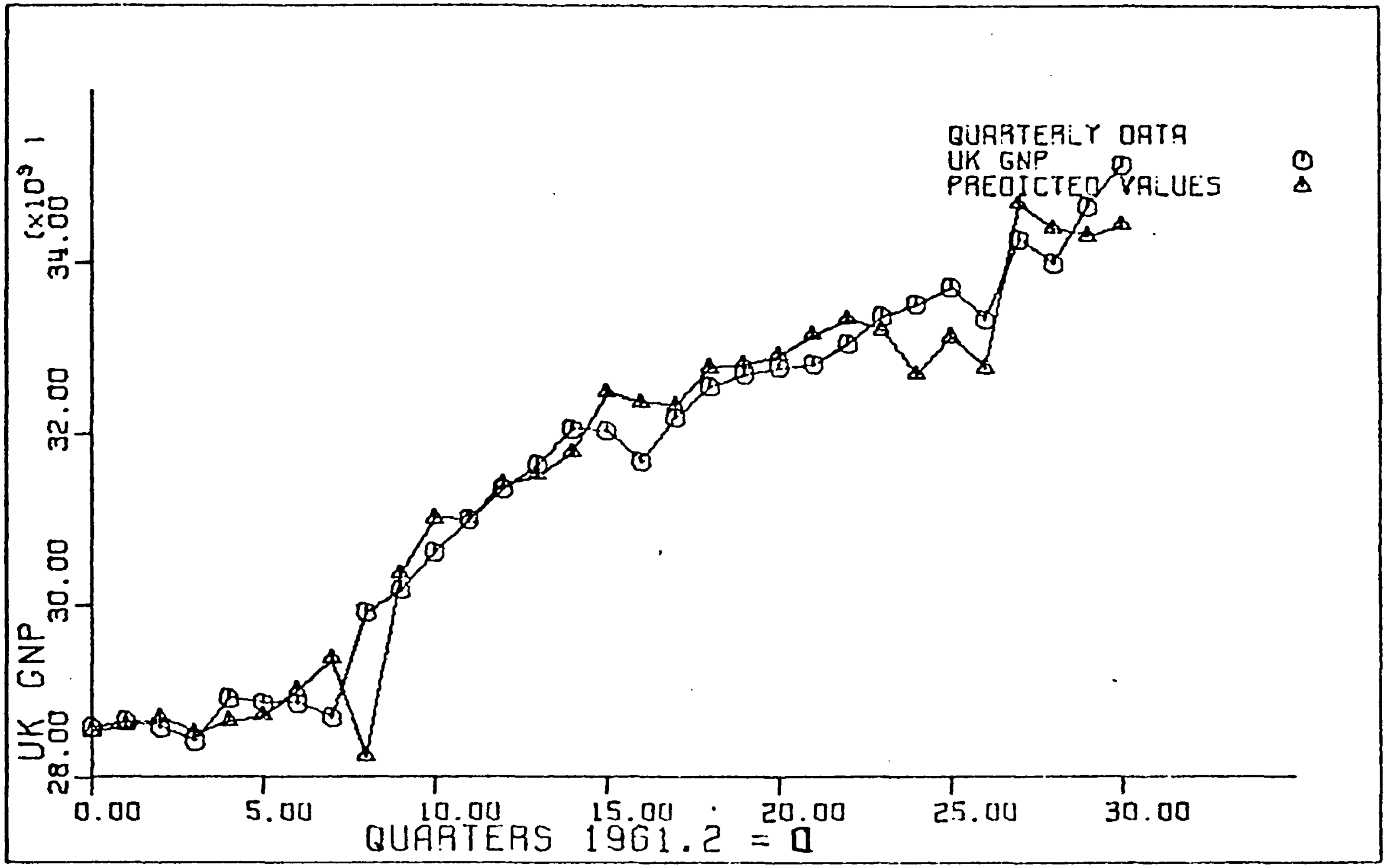

Figure B.19. Actual and predicted UK GNP, 1961 II - 1968 IV £ million

Table B.20. Actual and predicted values of UK taxes on expenditure 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	3828	3879	-51	-1.3
	III	3834	3877	-43	-1.1
	IV	3929	3923	6	0.2
1962	I	3941	3906	35	0.9
	II	3969	3962	7	0.2
	III	3980	3942	38	1.0
	IV	3997	3937	60	1.5
1963	I	3943	4020	-77	-2.0
	II	4096	4051	45	1.1
	III	4118	4116	2	0
	IV	4134	4255	-121	-2.9
1964	I	4162	4248	-86	-2.1
	II	4281	4365	-84	-2.0
	III	4337	4385	-48	-1.1
	IV	4495	4443	52	-1.2
1965	I	4584	4584	0	0
	II	4601	4581	20	0.4
	III	4604	4527	77	1.7
	IV	4681	4651	30	0.6
1966	I	4715	4694	21	0.4
	II	4789	4821	-32	-0.7
	III	4955	5221	-266	-5.1
	IV	5157	5101	57	1.1
1967	I	5180	5036	144	2.8
	II	5215	5101	114	2.2
	III	5277	5249	28	0.5
	IV	5346	5384	-38	-0.7
1968	I	5593	5499	94	1.7
	II	5601	5723	-122	-2.2
	III	5804	5859	-55	-0.9
	IV	6121	5978	143	2.3

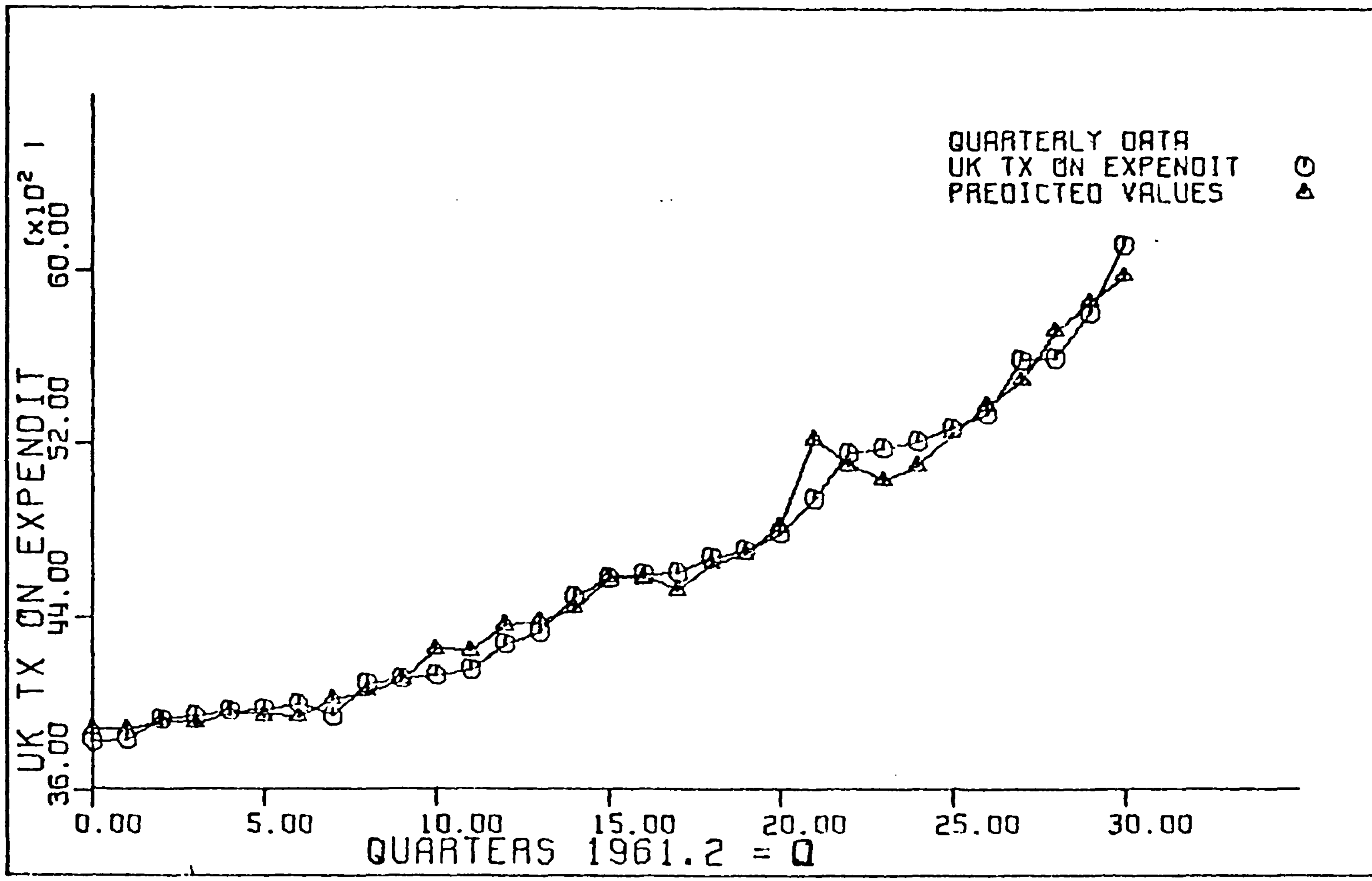

Figure 20, Actual and predicted UK taxes on expenditure, 1961 II - 1968 IV £ million

Table B.21. Actual and predicted values of UK taxes on income 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I				
	II	3287	3255	32	1.0
	III	3294	3292	2	0.1
	IV	3282	3311	-29	-0.9
1962	I	3427	3479	-52	-1.5
	II	3559	3451	108	3.0
	III	3572	3560	12	0.3
	IV	3617	3574	43	1.2
1963	I	3468	3595	-127	-3.7
	II	3524	3557	-33	-0.9
	III	3233	3157	76	2.4
	IV	3304	3255	49	1.5
1964	I	3321	3347	-26	-0.8
	II	3352	3452	-100	-3.0
	III	3436	3510	-74	-2.2
	IV	3578	3576	2	0.1
1965	I	3669	3691	-22	-0.6
	II	3633	3649	-16	0.4
	III	3703	3753	-50	-1.4
	IV	3899	3892	7	0.2
1966	I	4013	3954	59	-1.5
	II	3983	3976	7	0.1
	III	3880	3963	-83	-2.1
	IV	3914	3963	-49	-1.2
1967	I	4320	4370	-50	-1.2
	II	4457	4380	77	1.7
	III	4478	4432	46	1.0
	IV	4512	4413	99	2.2
1968	I	4677	4627	50	1.1
	II	4667	4730	-63	-1.3
	III	4727	4655	82	1.7
	IV	4740	4745	-5	-0.1

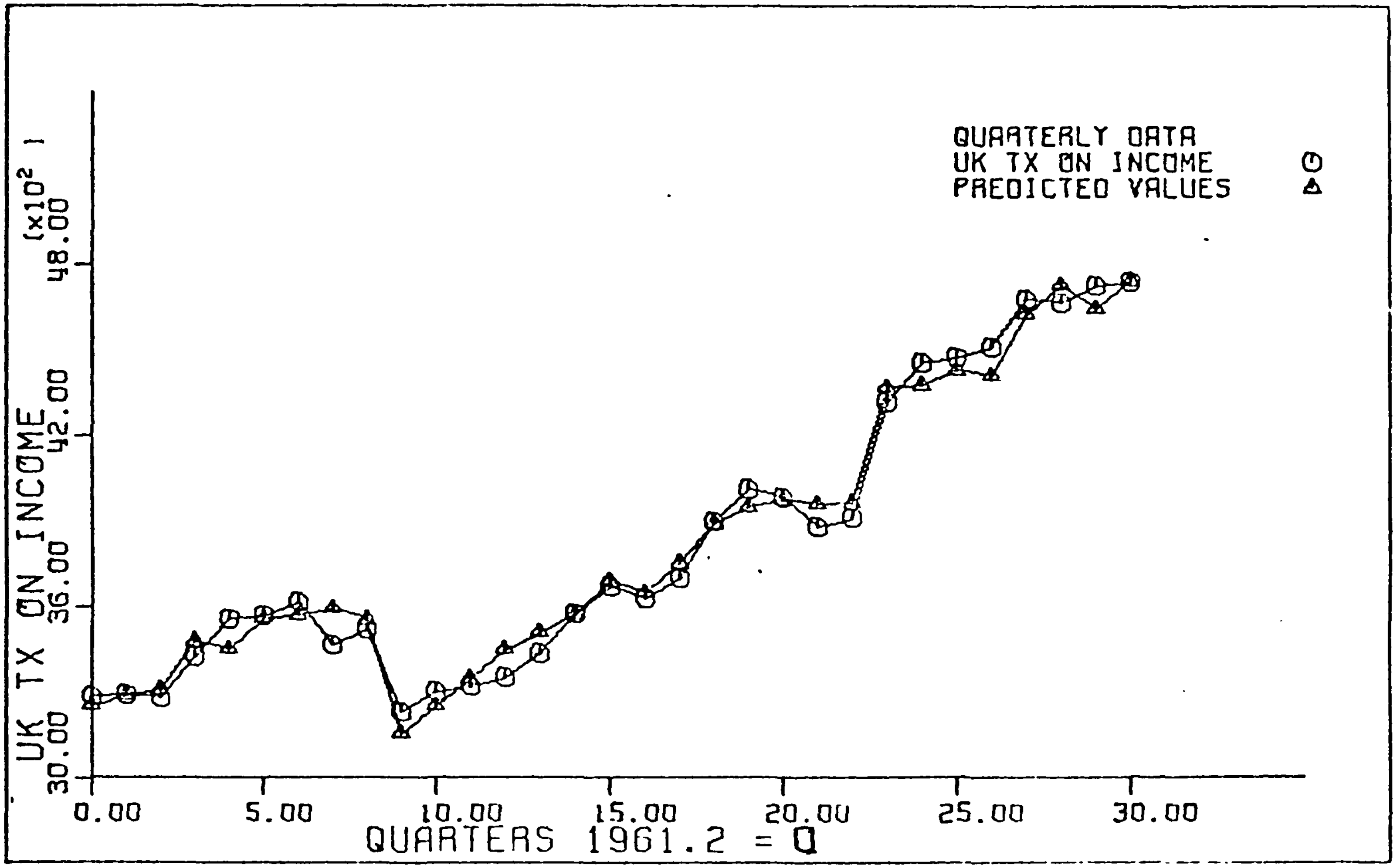

Figure B.21. Actual and predicted UK taxes on income, 1961 II - 1968 IV £ million

Table B.22. Actual and predicted values of UK depreciation 1961 II-1968 IV £ million

Year		A	P	R=A-P	R/A %
1961	I	.		.	
	II	2135	2127	8	0.4
	III	2155	2153	2	0.1
	IV	2174	2178	-4	-0.2
1962	I	2191	2188	3	0.1
	II	2209	2210	-1	0
	III	2231	2233	-2	-0.1
	IV	2257	2260	-3	-0.1
1963	I	2280	2294	-14	-0.6
	II	2303	2311	-8	-0.6
	III	2329	2335	-6	-0.3
	IV	2360	2359	1	0
1964	I	2391	2389	2	0.1
	II	2420	2420	0	0
	III	2449	2454	-5	-0.2
	IV	2476	2487	-11	-0.4
1965	I	2503	2495	8	0.3
	II	2531	2527	4	0.2
	III	2560	2559	1	0
	IV	2590	2591	-1	0
1966	I	2615	2624	-9	-0.3
	II	2641	2655	-14	-0.5
	III	2677	2687	-10	-0.4
	IV	2724	2719	5	0.2
1967	I	2777	2780	-3	-0.1
	II	2826	2812	14	0.5
	III	2859	2845	14	0.5
	IV	2878	2880	-2	-0.1
1968	I	2892	2913	-21	-0.7
	II	2914	2914	0	0
	III	2943	2948	-5	-0.2
	IV	2979	2984	-5	-0.2

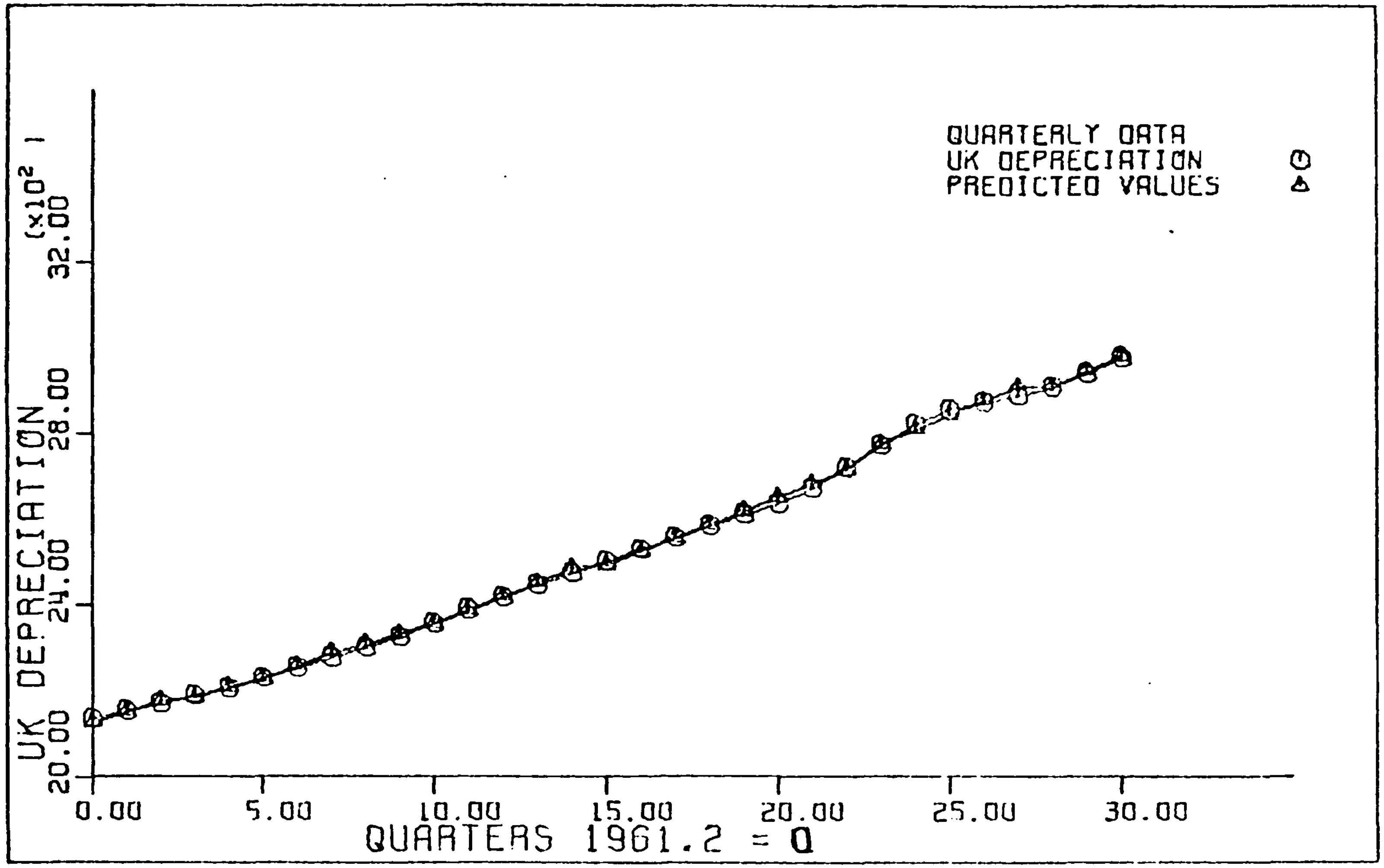

Figure B.22. Actual and predicted UK depreciation, 1961 II - 1968 IV £ million